MARCH 1977 75 CENTS

Popular Science

The What's New magazine ®

MICRO-PROCESSORS
Tiny overseers that run everything—from cars to ovens

Wankel Fanliner
Revolutionary private plane

CAR FILTERS—what to know, how to service 'em

News about rec vehicles: PICKUPS, VERSATILE VANS, NO-FRILLS CAMPERS

PARQUET FLOORS you install yourself

On the way: power for electric grids from FUEL CELLS

If a sedan is too small, a big station wagon to

INTROD

THE 1977

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xpensive, and a van too uncomfortable, take the Bus!

UCING VW BUS.

What? *You* drive a bus? Sure—why not? You have a family, don't you? Well, the new VW Bus was made for families, and vice versa. It gives you more of everything all at once: more room, more economy, more versatility, more comfort. And on top of all that, it's a lot more fun to drive. Just check it out against your other choices.

ROOM AND COMFORT

The '77 VW Bus not only beats a sedan hands down—it even outspaces a station wagon. In fact, it gives you 70% more room inside than a full-size, domestic station wagon. Put in everybody in the family, and we mean *everybody!* Up to seven people. You've still got plenty of room for your luggage, your dog, and your parakeet.

Or fold down the third seat and you just about triple the cargo area while you carry four people in style. Or if you really want to do some hauling, take out the middle seat, and now your Bus has as much deck area as a small truck.

How does it compare to a van? Your Bus is almost as roomy, but because the rear seats are not optional, it's a whole lot more comfortable. And a lot nicer, for that matter. In fact, the interior is beautifully finished.

VERSATILITY

See that rear hatch? And the big sliding door? They mean you can use your Bus like no other vehicle. One minute you're carrying the Little League team, or the whole dance class. The next you're taking home that antique dry sink you practically stole at the auction. Yet, because the Bus is shorter than most cars, it's easy to park. For all-around usefulness, there's nothing like your VW Bus.

ECONOMY

The '77 VW Bus costs only a little more to buy than the average domestic sedan and less than most big station wagons. And to run, it's out front by miles. The 2-liter engine is powerful and responsive, but it's also super-efficient, because it has electronic fuel injection which helps to give you an estimated 28 mpg on the highway, 20 in the city with standard transmission in the 1977 EPA tests. Of course your actual mileage may vary depending on where and how you drive, your Bus' condition and optional equipment.

DRIVEABILITY

Your Bus has fully independent suspension on all four wheels, and radial tires, which give you a smooth ride and excellent roadholding. It has ten-inch power-assisted front disc brakes, for sure stopping power. And just look at the visibility from the driver's seat. Together, they all add up to great handling, and more pleasurable driving. And you can choose a standard transmission or fully automatic.

From any angle, the '77 VW Bus is clearly a winner. So visit your Volkswagen dealer and see how much farther your money will go when you take the Bus. Just be sure to bring the whole gang with you. As we say, the '77 VW Bus is a family affair.

TAKE THE BUS

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MARCH 1977
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Popular Science

MONTHLY®

The What's New magazine

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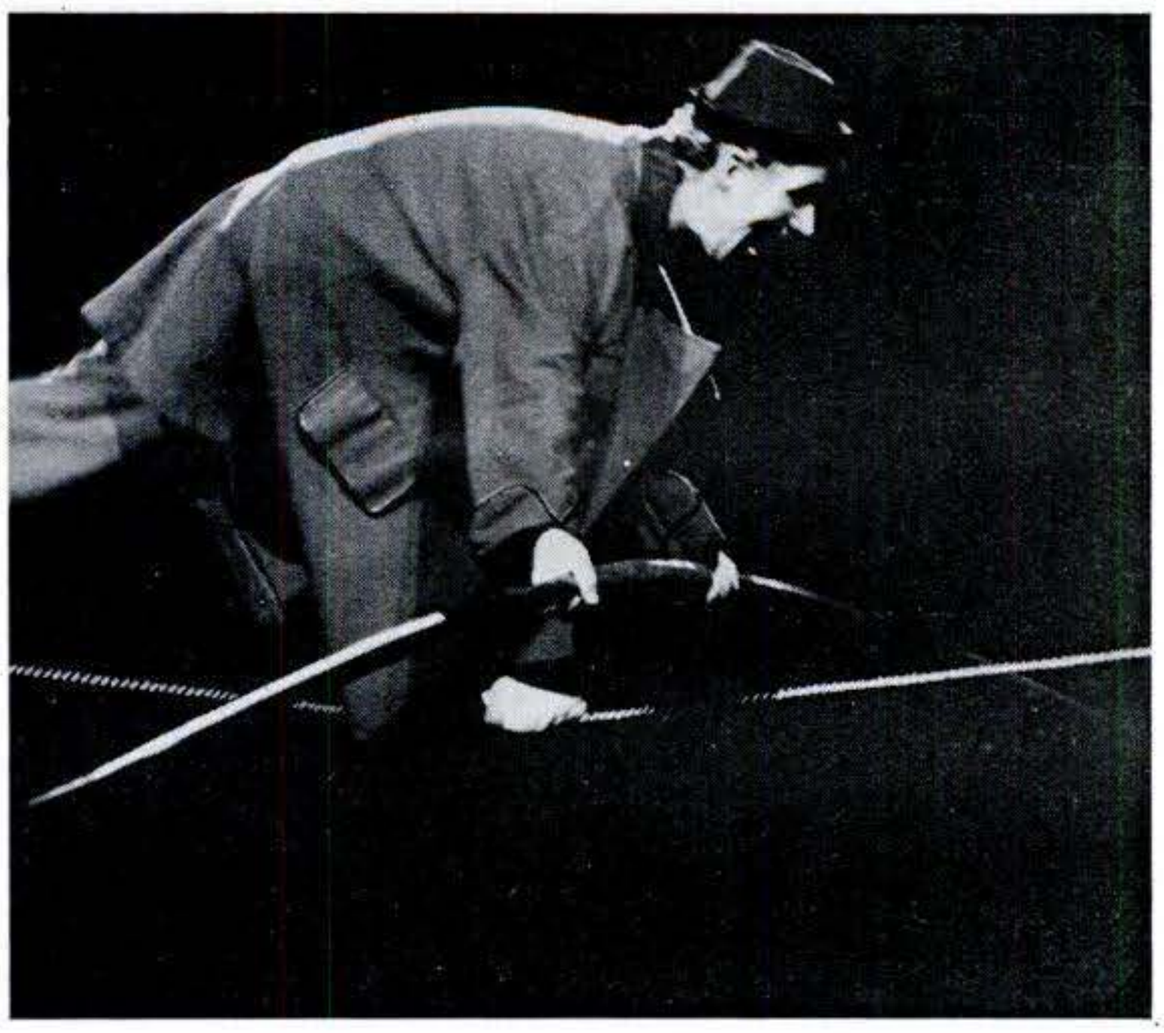
Skimping on engine protection is like skimping on a safety net.



When you consider the purchase of a quality AC Oil Filter, consider the job it must do. And compare its price to the important investment you have in your car.

The oil filter is a crucial part of your engine.

Engines wear out on the inside. Moving parts need clean oil to reduce friction, lessen wear. Yet, dirty oil can do just the opposite. It can act like fine sandpaper, grinding down the precious metals.

The cost of a good oil filter vs. the expense of replacing an engine.

And dirty oil does its best dirty work on rings, bearings and other parts that can be very, very expensive to replace.

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PS READERS TALK BACK

Magnetic-confinement progress

Congratulations on your recent article, "Energy from Laser Fusion" [Dec. '76]. The article is clearly written and balanced in its treatment of the problems and promises of controlled thermonuclear reactions through inertial confinement.

Why don't you bring your readers up to date on progress in magnetic-confinement research and development? Recent experimental successes in the Soviet Union and the United States have brought us much closer to the ion-temperature and density-confinement time product required for the reactor regime. We are beginning construction of the first large tokamak device—the Tokamak Fusion Test Reactor—which will burn deuterium-tritium, the reference fuel for power reactors. Aggressive programs in superconducting magnets, plasma heating systems, materials development, and other engineering-development problem areas are underway. Mirror machines, although still an alternate to the more promising tokamak configuration, demand more attention and are achieving the status of a national program. Encouraging experimental results, which have confirmed theoretical predictions, are reflected in substantial increases in budgets for magnetic fusion energy. The programs of other nations have gathered momentum along with the one in the U.S. The Soviets, the Japanese, and the Euratom countries are all preparing to build larger tokamaks (T-20, JT-60, and JET, respectively); some of these will employ superconducting magnets for the first time.

Robert W. Mason,
ERDA, Washington, D.C.

Timed thermostats

Evan Powell, in "Tune Your Thermostat" [Dec. '76], should have mentioned the method of thermostat timing described by Carl Sager [Feb. '75]. I recently installed a setup like Sager's and my total cost was only $34. I could have saved $9 of that by using my old thermostat. By combining the Tork 1101 with two thermostats you get more flexibility than with the devices Powell mentions, and at a far lower cost. Installation of Sager's system is a bit more involved but should take very little time if 120-volt power is readily available for the timer.

I feel that the light-sensitive thermostat that Powell calls the most "flexible" system is actually useless. The whole idea behind the timed thermostat is that it comes on automatically *before* you awaken. If you have to wake up to turn on a light, you might as well wake up and turn up the thermostat. Either way you have to sit around shivering for a half hour or so, unless you're the type who can take a shower in a 58° bathroom.

Michael Morse, Garrett Park, Md.

DIY computers

We enjoyed your article "Real Computers You Assemble Yourself" [Dec. '76]. You mention the communication gap between computer buffs and everyone else. There is a similar gap between hardware and software computer buffs. Computer clubs diminish this communication barrier by appealing to anyone interested. The Houston Amateur Microcomputer Club was formed a year ago and has since grown to 50 members. The presentation topics alternate between software and hardware. There is also a monthly informal meeting in which members are encouraged to bring news, problems, and even nonfunctioning machines. The club has spawned some spinoff special-interest groups that allow members to pursue a common interest at a more concentrated pace. It is obvious that the computer club will asume a major responsibility in sustaining the personal-computer boom.

Steve Smith, Houston, Tex.

In your article on do-it-yourself computers, no mention was made of how

Continued

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[*Continued*]

a person could get started in a hobby such as that. I would appreciate some information concerning this.

Scott Sollay, Lake Charles, La.

Bill Hawkins, our electronics editor, is preparing an article that will tell you what you need—and what it's like—to get started in personal computers. Look for it in an upcoming issue.

Windmobile

My sons and I were very pleased with Ben Kocivar's fine story on our Windmobile [Nov. '76]. However, I wish to correct two small errors: First, the range graph on page 104 is for the *present* Windmobile with its three batteries (not for the projected four-passenger, 10-battery version). The future version's range in zero-wind conditions is calculated to be about twice that of the present model, while the predicted wind speeds needed to achieve a 250-mile range are about the same.

Second, the Windmobile had its beginning in 1969 (not 1960). My son Douglas began building the landsailer in 1971, when he was 16.

Readers interested in following the further development and marketing of the Windmobile may want to get on SunWind's mailing list by writing to SunWind Ltd., Box 880, Sebastopol, Calif. 95472.

James L. Amick, Ann Arbor, Mich.

Your writer, Ben Kocivar, is wise to be skeptical about the ultimate practicality of the Amick Windmobile. The fatal flaw in the concept is that fixed airfoil. Any forward thrust on the vehicle that it develops is embarrassingly small compared with the simultaneous side thrust. This consequence immediately emanates from the fact that there is no such thing as a negative drag coefficient. (If there were, aircraft wouldn't need engines!) In plain language, the net wind force on the vehicle cannot be in a direction that exceeds a right angle to the apparent wind. For example, if the apparent wind is at the stated optimum 10°, then the net wind force has to be pushing on the vehicle at an angle that is greater than 80° to the leeward of the desired direction of travel. Even allowing for theoretical maximum performance of the airfoil, the best that could be attained at the indicated angle of attack would be a minimum angle of about 83.6°. This means that there are at least nine pounds of sideways thrust from the wind on the vehicle for every lonely little one pound of forward thrust. Think of the problems with tires, cornering, or wet pavements. It's like trying to tow a car with a rope stretched at nearly a right angle to the way the car is heading.

Warner Clements, Beverly Hills, Calif.

Inventor James Amick replies: Reader Clements is correct in his facts but, I think, overly pessimistic in regard to possible bad effects of side force. For the prototype Windmobile, the side force does not exceed 300 pounds at speeds below 55 mph in winds of 14 mph or less. This side force is only half of the estimated cornering-force capability of the vehicle.

Should high wind and vehicle speeds cause the side force to approach the cornering limit, the rear wheels will merely develop an increased slip angle which will yaw the vehicle into the wind just enough to reduce the side force to an equilibrium value. The front wheel will not be affected, so normal steering control will be retained. The vehicle will tend to slow down because of increased rolling resistance and reduced forward thrust. Iceboats commonly encounter this condition when their runners are dull.

Large side forces are an inherent part of modern high-speed sailing. Whenever an iceboat or landsailer travels at high speed, its sail is producing a side force many times larger than the forward force it gives.

In a rainy and windy climate on the west coast of Sweden I am reading

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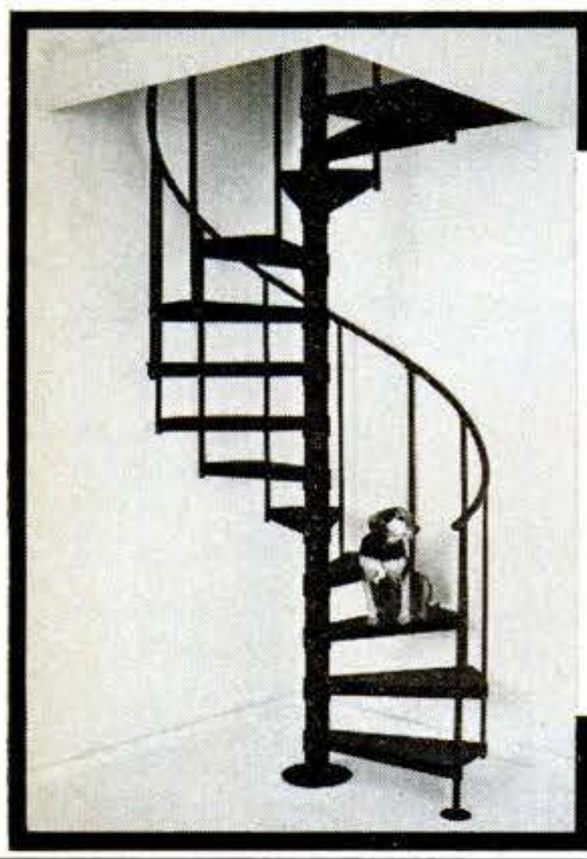

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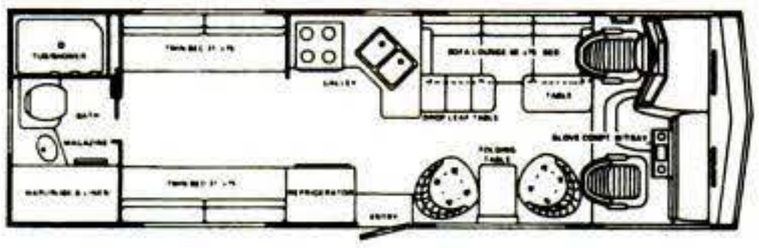

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Pocket CB

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Scientists have produced a personal communications system so small that it can easily fit in your pocket. It's called the PocketCom and it replaces larger units that cost considerably more.

MANY PERSONAL USES

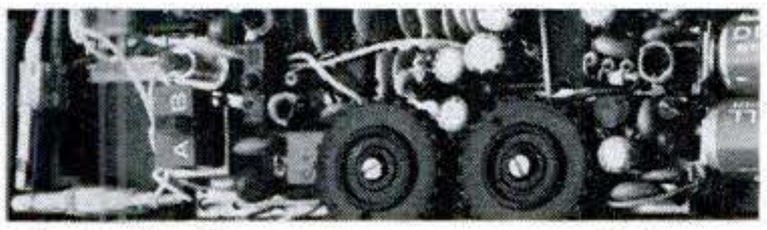
An executive can now talk with anybody in his office, his factory or job site. The housewife can find her children at a busy shopping center. The motorist can signal for help in an emergency. The salesman, the construction foreman, the traveler, the sportsman, the hobbyist—everybody can use the PocketCom.

LONG RANGE COMMUNICATIONS

The PocketCom's range is limited only by its 100 milliwatt power and the number of metal objects between units or from a few blocks in the city to several miles on a lake. Its receiver is so sensitive, that signals several miles away can be picked up from stronger citizens band base or mobile stations.

VERY SIMPLE OPERATION

To use the PocketCom simply turn it on, extend the antenna, press a button to transmit, and release it to listen. And no FCC license is required to operate it. The PocketCom has two Channels—channel 14 and an optional second channel. To use the second channel, plug in one of the 39 other citizens band crystals and slide the channel selector to the second position. Crystals for the second channel cost $7.95 and can only be ordered after receipt of your unit.



The PocketCom components are equivalent to 112 transistors whereas most comparable units contain only twelve.

A MAJOR BREAKTHROUGH

The PocketCom's small size results from a breakthrough in the solid state device that made the pocket calculator a reality. Scientists took 112 transistors, integrated them on a micro silicon wafer and produced the world's first transceiver linear integrated circuit. This major breakthrough not only reduced the size of radio components but improved their dependability and performance.

BEEP-TONE PAGING SYSTEM

You can page another PocketCom user, within close range, by simply pressing the PocketCom's call button which produces a beep tone on the other unit if it has been left in the standby mode. In the standby mode the unit is silent and can be kept on for weeks without draining the batteries.

SUPERIOR FEATURES

Just check the advanced PocketCom features now possible through this new circuit breakthrough: 1) Incoming signals are amplified several million times compared to only 100,000 times on comparable conventional systems. 2) Even with a 60 decibel difference in signal strength, the unit's automatic gain control will bring up each incoming signal to a maximum uniform level. 3) A high squelch sensitivity (0.7 microvolts) permits noiseless operation without squelching weak signals.

EXTRA LONG BATTERY LIFE

The PocketCom has a light-emitting diode low-battery indicator that tells you when your 'N' cell batteries require replacement. The integrated circuit requires such low power that the two batteries, with average use, will last weeks without running down.

The PocketCom can be used as a pager, an intercom, a telephone or even a security device on all 40 CB channels.

MULTIPLEX INTERCOM

Many businesses can use the PocketCom as a multiplex intercom. Each employee carries a unit tuned to a different channel. A stronger citizens band base station with 23 channels is used to page each PocketCom. The results: an inexpensive and flexible multiplex intercom system for large construction sites, factories, offices, or farms.

NATIONAL SERVICE

The PocketCom is manufactured exclusively for JS&A and is the unit currently used on the hit TV show, Charlie's Angels. JS&A is America's largest supplier of space-age products—further assurance that your modest investment is well protected. The PocketCom should give you years of trouble-free service, however, should service ever be required, simply slip your 5 ounce PocketCom into its handy mailer and send it to our prompt national service-by-mail center.

The PocketCom measures approximately ¾" x 1½" x 5½" and easily fits into your shirt pocket. The unit can be used as a personal communications link for business or pleasure.

GIVE IT A REAL WORKOUT

Remember the first time you saw a pocket calculator? It probably seemed unbelieveable. The PocketCom may also seem unbelieveable so we give you the opportunity to personally examine one without obligation. Order only two units on a trial basis. Then really test them. Test the range, the sensitivity, the convenience. Test them under your everyday conditions and compare the PocketCom with larger units.

After you are absolutely convinced that the PocketCom is indeed that advanced product breakthrough, order your additional units, crystals or accessories on a priority basis as one of our established customers. If, however, the PocketCom does not suit your particular requirements perfectly, then return your units within ten days after receipt for a prompt and courteous refund. You cannot lose. Here is your opportunity to test an advanced space-age product at absolutely no risk.

A COMPLETE PACKAGE

Each PocketCom comes complete with mercury batteries, high performance Channel 14 crystals for one channel, complete instructions, and a 90 day parts and labor warranty. To order by mail, simply mail your check for $29.95 per unit (or $50.00 for two) plus $2.50 per order for postage, insurance and handling to the address shown below. (Illinois residents add 5% sales tax). But don't delay.

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Phone (_____)_____

[*Continued*]

your "sunny" article about the hybrid Windmobile. Many electric cars have been constructed, but never one that puts together three power sources. Wind, electricity, and later even solar power can combine to give a really acceptable range.

The Windmobile's range could be increased further with our newly developed direct-drive in-wheel motors. These permanent-magnet digital-pulsed motors even have regenerative braking.

But the suggestion in the article to install a small wind generator to charge batteries is a technical miss, because the rolling resistance of the car will increase more than the power delivered by the generator to the batteries.

This project should be given all possible support by the government.

Erich Adickes,
Elbilar ab, Göteborg, Sweden

Wrong exposure

In his column "Through the Viewfinder" [Dec. '76], Everett H. Ortner reported that the forthcoming MX and ME Pentaxes are both automatic-exposure cameras. I believe, on closer observation, you'll find that only the ME is auto-exposure, while the MX is manual.

You have an excellent magazine and an occasional error only proves you're human, too.

Del Ortman, Marion, S.D.

Ortner to Ortman: You're right about the Pentaxes.

For thermistor shoppers

In reference to your article "Simple Fix Gives Long Life to Projector Bulbs" [Nov. '76], I tried to find the thermistor FRT-2, but was told that Workman Electronic Products had no catalog number for it. In other words, they do not sell it as a separate item, but do have a FRTV-2, which has a capacitor with it that can be thrown away, but you end up paying for both.

John Patton, San Diego, Calif.

Lawrence Betz replies: It is unfortunate that Mr. Patton's dealer, lacking the FRT-2 thermistor in stock, could not guide him to a substitute. It's true that Workman does not list the FRT-2; it is sold over the counter as a "Heavy Duty Universal Globar Disc." As a substitute, a GB-2 unit from Oneida Electronic Mfg. Co. may be available.

An important word of caution: Mr. Patton's dealer gave the impression that the FRTV-2 could be used. This is a matched pair of thermistor and varistor, not a capacitor, according to the catalog. The varistor must not be used because it has positive resistance characteristics.

Don't mess up motorcycles

"Covered Motorcycle" [Nov. '76] surely gives me something to get off my chest! A cycle is a magnificent machine. Why take away the thrill of the open highway by enclosing yourself in a shell? If rain is the problem, the proper-size windshield would produce the same effect as an awkward protective shell, and without all that weight. If you're going this far, why not add two more wheels to complement its disk brakes and reclining seat and call it a car? Motorcycles have gotten along just fine all this time—why change a good thing?

Jan Johnson, North Freedom, Wis.

R-values—how valuable?

I have been following your energy series carefully and have been delighted and inspired by many of the original ideas. You did drop your guard slightly, however, in Al Lees' reply to James Shields' inquiry on insulation in this column [Dec. '76].

All insulations labeled R-19 (or any other value) are *not* the same for a very obvious reason, once you know the problem. Insulations are tested for thermal conductivity by the so-called "guarded hotplate" method. This means that the insulations to be tested must first be dried to zero-moisture content in an oven or in a desiccator. Moisture in insulation dramatically increases its thermal conductivity. Because of this, closed-cell insulations, such as polystyrene foam and urethane foam, will perform as expected in normal service; but open-celled, porous materials such as glass fiber or mineral wool (unprotected) can lose most of their resistance on a cold, damp, windy day in a climatic area represented by Boston or New York. An unprotected, open-celled R-19 can become an R-4 or R-5, incorrectly installed in the wrong climate.

S. A. Stewart,
Rancho Palos Verdes, Calif.

Al Lees replies: What reader Stewart says about how R-values are assigned is true. What he implies about performance is dubious. For an R-19 mineral-wool bat to drop to R-4 would require an unusual combination of cold, damp, windy weather (severe cold is rarely damp) and deliberately improper installation. Furthermore, Mr. Stewart neglects to mention that the foam insulations don't retain their original R-values either. Through chemical change, they drop in efficiency after manufacture. Eventually they stabilize, but often after installation. There's no such thing as a perfect insulation, but there's no real doubt that all types we've mentioned are effective—and the relative effectiveness is reflected in their assigned R-values.

Want to get something off your chest?
Write "Readers Talk Back,"
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How to Achieve Total Financial Freedom

"Millionaires Are Not 100 Times Smarter Than You, They Just Know The Wealth Formula"

Millionaires are not 100 or even 10 times smarter than you, but it is a fact that millionaires are making 10 to 50 and even 100 times more than you.

Are these wealthy people working that much harder than you? No way!

If you are working only 20 hours a week, it would be physically impossible. (There are only 168 hours in a week, no one gets more.)

These questions used to really stump me. That was six years ago.

My wife and I then lived in Denver, Colorado, at 2545 South High Street. We paid $135 a month rent for a cramped, tumbled down house. My wife was expecting our second child and we were flat broke. I felt desperate and forced into a corner. I had to borrow $150 from my father and another $150 from my father-in-law just to buy the groceries and pay the rent. If that wasn't enough, we were several thousand dollars in debt.

Things are much different now. Last year I could have retired and lived off the income of my one million dollars in real estate holdings. (Incidently, almost all of the income from the real estate is tax free).

Since I had worked 20 to 40 hours a week, I know that I didn't work even 10 times longer or harder than you. And with my C-average from Ames High School (located in Ames, Iowa). I'm quite certain that I'm not any smarter than you.

If hours, efforts, or brains are not what separates the rich from the average guy who is swamped with debts and very little income, then what is?

I learned the answer to that question from an old fellow in Denver. This fellow worked in a drug store stocking the shelves. Very few people knew that he had $200,000 in the bank, all of which he had earned starting from nothing.

Within a year after meeting him, I was told and shown the same thing by a young man who had recently earned over a million dollars. By this time, I began to realize that what I was being shown was truly a remarkable and workable way to grow rich.

I began to apply the principles and methods I had been shown. The results were amazing. I couldn't believe how easy it was, in fact it seemed too easy.

MARK O. HAROLDSEN
32 Year Old Millionaire

But then I met an elderly lady (83 years old) who, although not very smart, has made $117,000 using the same formula.

I then figured my beginning wasn't luck.

For three and one half years, I worked hard to refine and improve on the formula that I had been shown, so that it would be easy to get quicker results.

As I did this, my assets multiplied very rapidly (160% per year) to the point that I didn't have to work any longer.

I guess I am bragging now, but I did start spending alot of time in our back yard pool, traveling around the country, and doing a lot of loafing.

Then one day a friend asked me how he could do what I had done.

So I began to outline the formula that I had improved to show him really how simple it was, and how he could do the same thing.

By the next time he approached me, I had written almost a complete volume on the easy way for him to copy my results.

I wrote this in simple, straight forward language so anyone could understand it.

This time my friend's questions were very specific. (He had already begun buying properties with the formulas I had been giving him). Now he had a property he wanted to buy, but was out of cash. How could he buy it?

I not only showed him how to buy without cash, but by the time the deal was complete, he had $5,000 cash in his pocket to boot.

I also showed him how to buy a $26,000 property for $75 down.

You, or anyone, can do exactly what I did, or my close friends have done; in fact, you may well do it better. (I began doing this in my spare time only).

It doesn't matter where you live or the size of your town or city, my formula will show you exactly how to:

- Buy income properties for as little as $100 down.
- Begin without any cash.
- Put $10,000 cash in your pocket each time you buy (without selling property).
- Double your assets every year.
- Legally avoid paying federal or state income taxes.
- Buy bargains at 1/2 their market value.
- Allow you to travel one week out of every month.

When you send me a check or money order for $10, I will send you all my formulas and methods, and you are free to use them anywhere and as often as you would like.

Now if you were a personal friend of mine, I know you would believe me and not need any kind of guarantee, but since you don't know me personally, I will guarantee that you will be completely satisfied and that my formula will work for you if you apply it. I will back up that guarantee by not cashing your check for 30 days, and if you for any reason change your mind, let me know and I will send your uncashed check back.

You may well ask, why am I willing to share my formula for wealth? Well, because many of you will probably seek further consultation and direction from me as your wealth rapidly grows and my consultation fee of $75.00 an hour adds to my fortune.

But you shouldn't care if I profit as long as you profit. And I guarantee that you will.

By the way, if you feel a little uneasy about sending me a check or money order for $10.00, simply postdate it by 30 days which will completely eliminate your risk.

REFERENCES

Community Bank & Trust, 940 W. South Temple, Salt Lake City, Utah
Zions Bank & Trust, 1 South Main Street, Salt Lake City, Utah
Charles F. Huber, Certified Public Accountant, 220 South 2nd East, Salt Lake City, Utah

I HEREBY CERTIFY THAT ALL THE ABOVE STATEMENTS ARE TRUE AND FACTUAL TO THE BEST OF MY KNOWLEDGE AND THAT I HAVE KNOWN MARK O. HAROLDSEN FOR MORE THAN FOUR YEARS. DURING WHICH TIME HE HAS ACCOMPLISHED THE THINGS HE HAS INDICATED ABOVE.

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RECREATION ROUNDUP

By HERBERT SHULDINER

New trends in RV's

The spectacular popularity of vans and pickup trucks [see "PS Car Test" and "Pickup Trucks" elsewhere in this issue] has spurred a lot of new thinking in Detroit about what you want to drive. RV makers and truck manufacturers are working up some new ideas as alternatives both to vans for big, comfortable towing, and to recreational vehicles. It seems that most of these rigs will be built on pickup-truck chassis.

I recently saw a couple of prototypes of such vehicles at RV shows in Los Angeles and in Louisville. The Family Cruiser, produced by International Harvester, is a gussied-up Scout Traveler (top two photos above) that's designed for more comfortable highway driving. The Traveler is built on a modified pickup chassis. The high-backed bucket seats both swivel and recline, and its floor is covered with padding and shag carpeting.

"We believe the Family Cruiser represents a logical next step in providing an excellent towing vehicle that offers off-road mobility, fuel economy, ample cargo-carrying capacity, and passenger comfort" says F. J. Wendling, International's light line marketing manager. The package will be available in both two-wheel and four-wheel-drive versions, he says, at about $470 above the price of the Traveler with custom options.

Another interesting approach to civilizing the pickups is the slick-looking Super Truck package from Winnebago (bottom photo). Winnebago sells the components that turn half- and three-quarter- ton pickups into quiet, comfortable passenger carriers. In addition to that smart cap that covers the bed, you can buy interior carpeting, cabinets, cushions, lighting fixtures—even a TV. The package—which includes spoilers, air scoops, and a custom exterior paint job—is available for any domestic truck and for six- or eight-foot beds. Without the TV, total price is about $2000.

More mpg on the way

A big jump in fuel economy is set for 1979-model pickup trucks, vans, and four-wheel-drive vehicles, if the federal government can push through a new proposed standard. The National Highway Traffic Safety Administration wants manufacturers of these rigs to build '79 models capable of 18.7 mpg.

If NHTSA can make its standard stick, manufacturers will be liable to fines of five dollars for each one-tenth mpg the average falls under 18.7 mpg, multiplied by the number of vehicles covered by the standard.

NHTSA says the 18.7-mpg standard would save 104.5-million gallons of gas over the life of the '79 fleet of 4WD's, vans, and pickup trucks, compared to gas consumption of the 1976 models.

The standard will apply to all vehicles rated at 6000 pounds gross vehicle weight. NHTSA says there may be a future standard for vehicles in this class with GVW's of up to 10,000 pounds.

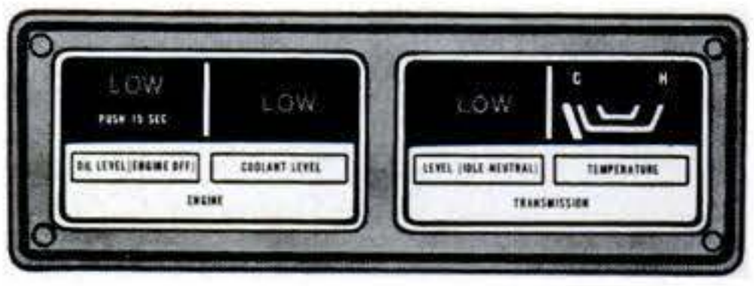
How are the manufacturers going to achieve the improved fuel economy? That's up to them, the agency says, but it suggests the most practical means would include the use of smaller engines, more economical gear ratios, and lighter vehicles.

Front-drive mini motor home

Argosy has a prototype of a new mini motor home built on a Toronado chassis. It's expected to be ready for the 1978 season. It will be the first front-drive mini motor home on the market.

Sensor for motor homes

Dodge is introducing a new RV sensor package this year that tells you at a glance when your engine oil, coolant, or transmission oil are at low levels. The dashboard-mounted unit also senses the temperature of your transmission oil. It makes it unnecessary to open the hood for such routine checks.



Rabbit vans, pickups

Vans and pickups that won't have any trouble meeting the proposed fuel-economy standards for utility vehicles may be on the way from VW. The German automotive giant is contemplating building pickups and vans on its very economical Rabbit chassis. In fact, we've learned that some prototypes have already been constructed and tested. No final decision has yet been made as to whether or not they will go into production.

Transcontinental bike trips

If you missed the Bikecentennial last year [PS, March '76], get your bike in shape for 1977. The Bikecentennial organization is offering lots of new trips of varying lengths and duration.

The Trans America trip costs $945 and includes lots of camping out. Every fifth night, however, will be spent in an indoor hostel-type facility. Food, insurance, leader's costs, guide books, and maps are covered by the fee, as well.

There are also lots of new loop trips, 300 to 400 miles long, from eight to 15 days. Lowest priced trips start at $120 for eight days. The major loop routes will run from Portland, Ore., Louisville, Ky., and Washington, D.C. They're designed for groups of seven to nine people, says Matthew T. Cohn, communications director for the Bikecentennial group.

About 4100 people made the coast-to-coast trip last year. About 95 percent of the route is unchanged from last year, but there has been an effort to eliminate all gravel sections to make it easy on your tires.

For more information and an application form, write Bikecentennial, Box 1034, Missoula, Mont. 59801. PS

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The legend continues...

Introducing the world's most sophisticated Diesel passenger car. The new Mercedes-Benz 300D.

The new, 5-passenger Mercedes-Benz 300D — the state of the Diesel passenger car art.

Here is a most ingenious alternative to the conventional automobile. A truly remarkable new Mercedes-Benz. With a contemporary new look. With ample room for five people, an astonishing 5-cylinder engine and an unusually complete array of luxurious appointments and safety systems. The new 300D. The most sophisticated Diesel passenger car the world has ever seen.

For years, you've heard about exotic and promising alternatives to the conventional automobile engine. To date, only one alternative has kept its promise: the Diesel engine — for over 60 years, the most efficient combustion power plant in use.

Now Mercedes-Benz has synthesized its proven, 5-cylinder Diesel engine with new, technologically advanced body design, suspension, steering and safety systems to produce the most ingenious alternative to the conventional automobile.

A matter of taste

Though only a trim 190.9 inches from bumper to bumper, the new 300D is an honest 5-passenger sedan. The secret of its spaciousness lies in new Mercedes-Benz technology that puts the room in the car *in* the car — without adding bulk or sacrificing safety.

Enter a new 300D and you're surrounded by a complete array of security and convenience features. All are standard equipment. Such things as cruise control, bi-level climate control, electric windows, AM/FM radio, central locking system, 3-speed windshield wipers.

The new 300D is not an exercise in opulence. But it does exhibit meticulous taste. And as your senses will tell you, there's quite a difference between the two ideas.

Sports car handling

The new 300D is one of the most sparkling road cars Mercedes-Benz has ever engineered. Its sophisticated power train, suspension and steering are those of a sports car. And that is why the new 300D handles like one.

The new 300D's unique, 5-cylinder engine is the most powerful, the smoothest Diesel yet engineered into a passenger car. But you pay no penalty for this performance bonus. The EPA estimates that the new 300D should deliver up to 28 mpg on the highway, 23 mpg in town. (Your mileage will depend on how and where you drive and the condition and equipment of your car.)

The state of the art

For over 40 years, Mercedes-Benz has pioneered many of the major advances in Diesel passenger car engineering. The new 300D is the culmination of that experience. It is the state of the Diesel passenger car art.

Test drive the new 300D. Experience the most ingenious alternative to the conventional automobile. The most sophisticated Diesel passenger car in the world.

Mercedes-Benz

Engineered like no other car in the world.

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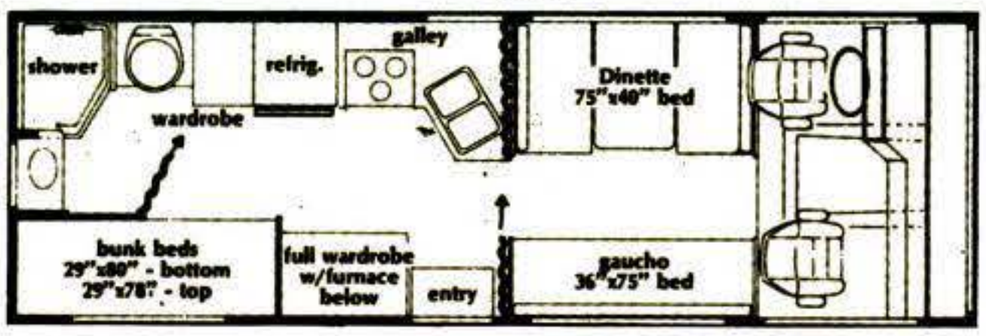
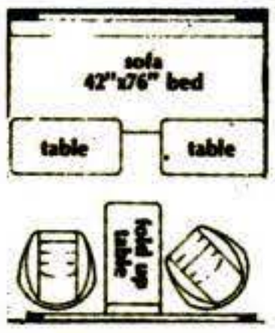
1977 Southwind
"BEST INVESTMENT"

The 1977 Southwind is a full size, no nonsense family motor home for families on a budget. Available in five models from 21′ to 28′ long, each has all basic equipment on board for pleasurable vacations. If you're ready for a "best investment," select a rear stateroom, side bath or entertainment center plan. An impressive option list allows you to make Southwind your choice.

Model J-25′

Families like yours will like the rear bunkhouse and spacious bath. Sleeps 4. Available now from Southwind dealers.





Prefer a living room? It's an option available from Southwind.

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Put a torch to your home repair bills.

A BernzOmatic propane torch, that is. It can help you save time and money on all types of household jobs. Inside, outside, all around the house.

Inside the house, your BernzOmatic propane torch will solder copper pipes, copper valves and elbow connections. It can thaw frozen pipes, seal an unwanted drain and loosen stubborn pipe joints. Or use it to connect electrical wires.

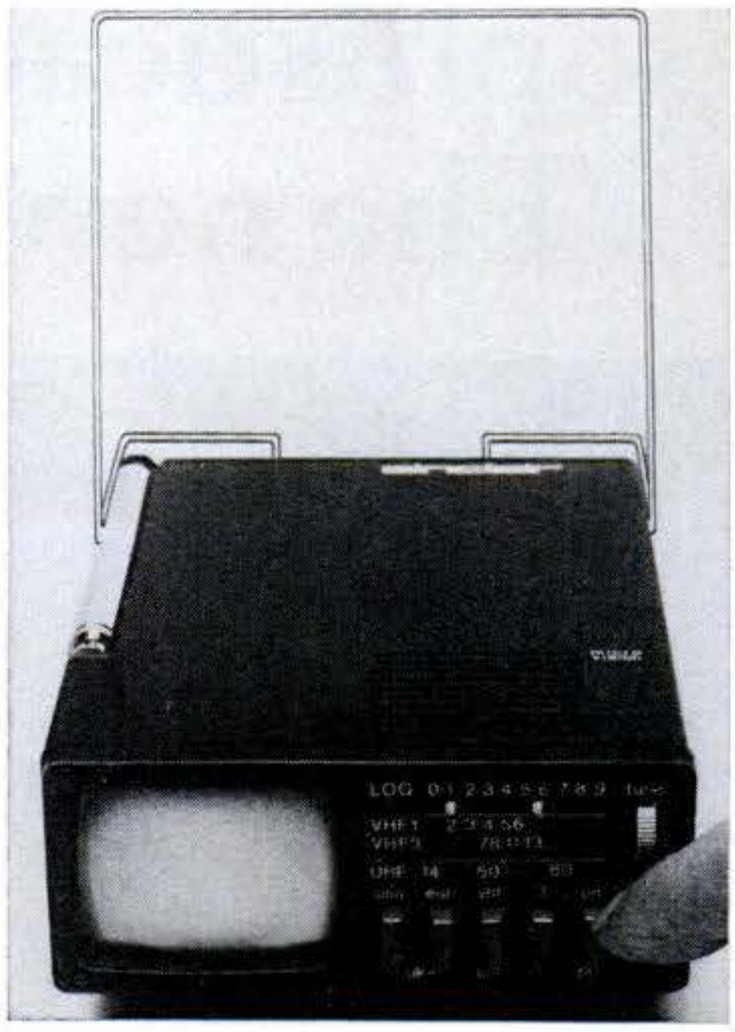
Outside, your BernzOmatic propane torch can back out rusted-on nuts and bolts from your car wheel, for example. Use it for removing exterior paint or window putty or repairing leaky gutters.

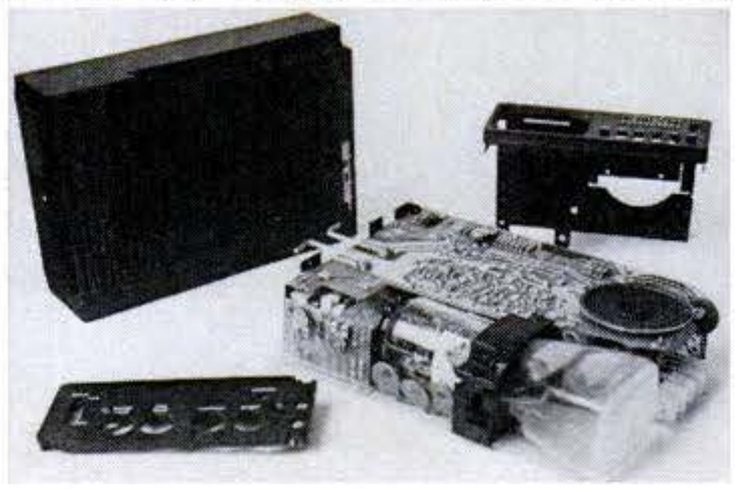
All around the house, your BernzOmatic propane torch will help simplify dozens of household jobs—from laying floor tile to raising grain in wood to furniture repairing. And it's ideal for dozens of hobby and craft applications.

Visit your BernzOmatic dealer and find out why the BernzOmatic propane torch is the do-it-yourself favorite of handy men and women.

BERNZ O MATIC®

Tiny TV
has 2-inch screen





Push buttons select black-and-white TV stations throughout the world for vernier tuning (VHF and UHF). New low-power electrostatic tube helps provide four-hours' viewing on single battery charge. Tiny set uses 300 transistors.

After a 12-year research project, Sinclair Radionics has launched Microvision, a pocket-size TV receiver only four inches wide, six inches long, and 1.5 inches deep.

A big problem was developing a low-power picture tube. "It's easy enough to make a small tube," says Clive Sinclair, the British firm's founder, "but the problem is power consumption." According to Sinclair, the two-inch-diagonal tube required "some radical innovations" to cut the power requirements of the tube's heater to one-twentieth that of previous tubes.

The 26-ounce $300 set has most of its circuitry on five integrated circuits. In assembly, only four printed-circuit boards and the tube are connected. It's housed in a three-piece steel casing to withstand rough handling. Set receives British, European, or U.S. TV signals.—*John R. Free*

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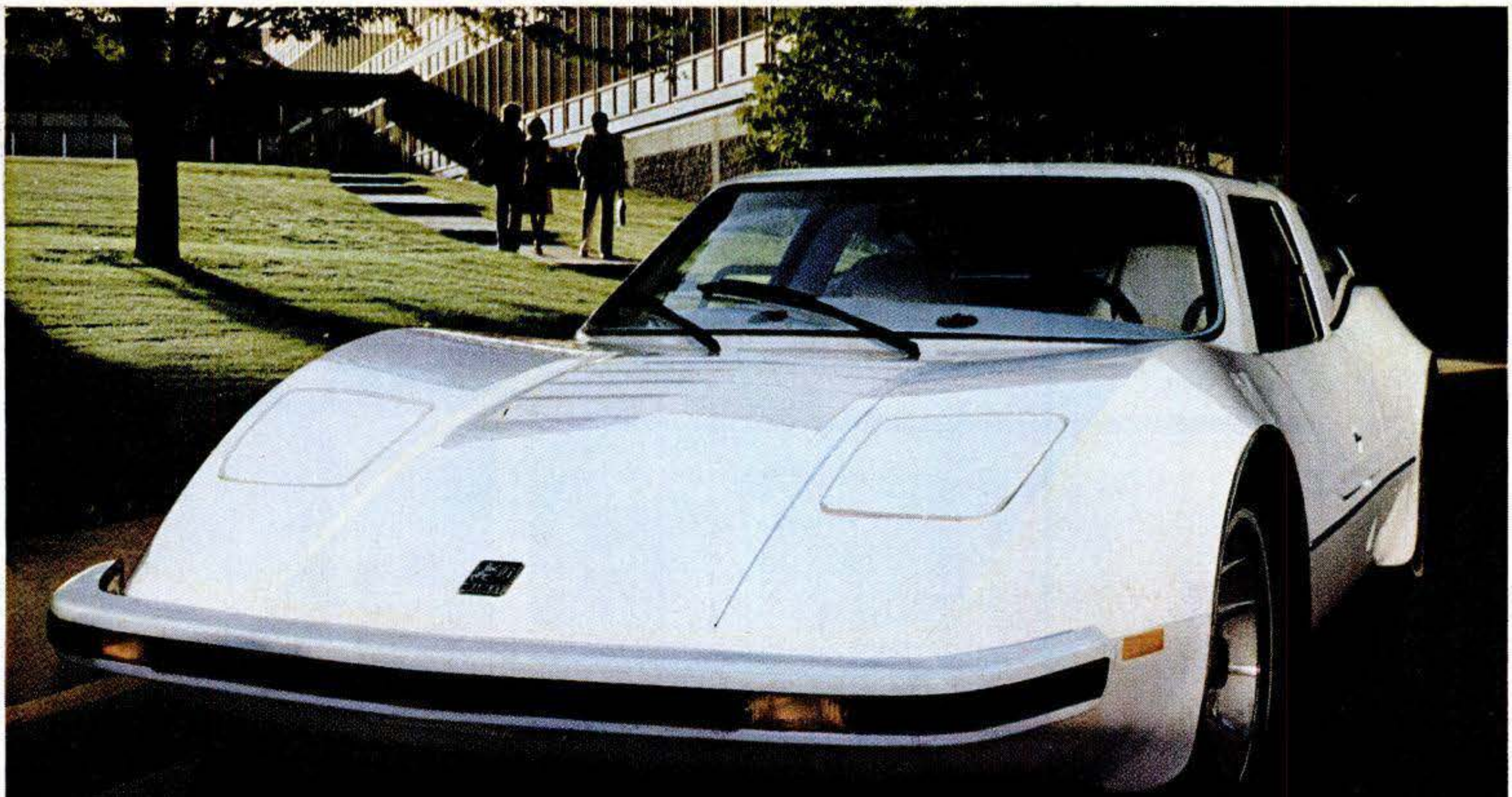


Introducing an exciting new concept in autodynamics.

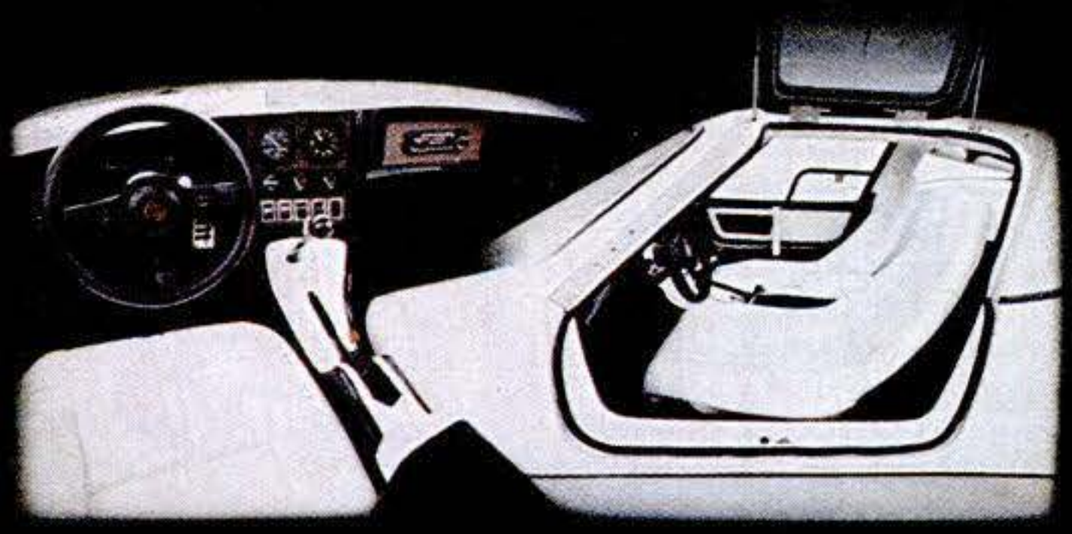
The Bradley GT II.

Nothing in the motoring world so dramatically combines the style and performance of the finest European sportscars with the economy and dependability of a VW. Each component of the GT II car kit is custom-designed for precision fit and easy assembly on a Volkswagen chassis. The totally-engineered, finely-crafted finished product is a reflection of your own good taste and individuality. A product with unique autodynamic properties that provide significantly improved performance. And with styling so reminiscent of the most expensive and lavish European sportscars.

Its many amenities include fiberglass gull-wing doors and hatchback rear door. A steel reinforced roof and fiberglass body. Tinted safety glass windows. European-styled instrument cluster. Electrically-powered pop-up headlamps. And so much more.

The all-new Bradley GT II car kit. An exciting new concept in autodynamics. Available in a choice of beautiful colors, all with color coordinated interior.

Send $1.00 for the 4/color Bradley brochure, write Bradley, 495 Shelard Plaza, 400 County Road 18 South, Minneapolis, Minnesota 55426.



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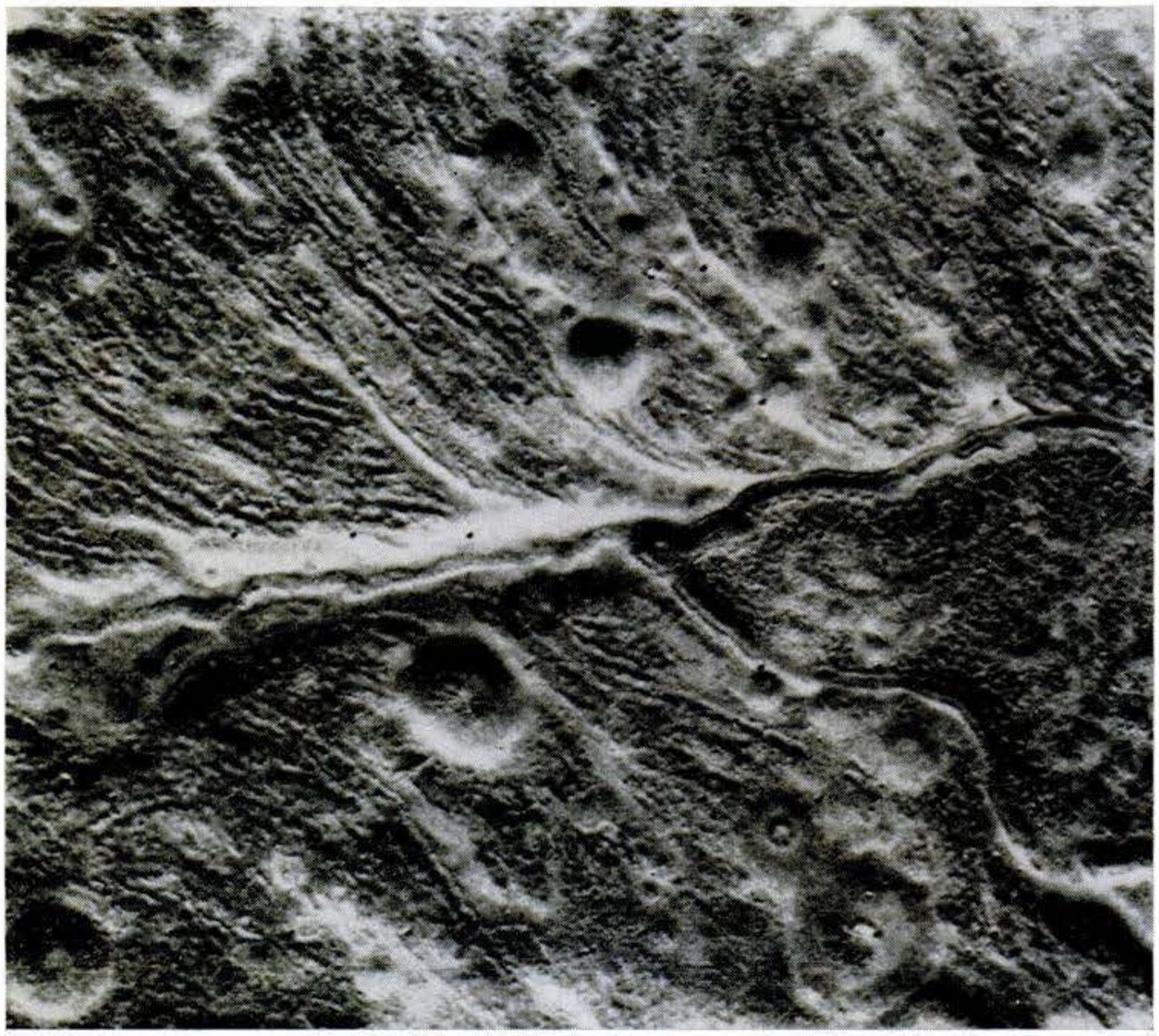
SCIENCE NEWSFRONT

BY ARTHUR FISHER



Martian mysteries

Space scientists are being tantalized by this photo of the Martian surface, taken last fall by Viking Orbiter 1 from a distance of 2200 kilometers. The low ridges with the Y-shaped intersection near the center of the picture may be the remnants of volcanic channels filled with congealed lava from ancient volcanic flows. But the ridges don't have the topography of typical lava flows.

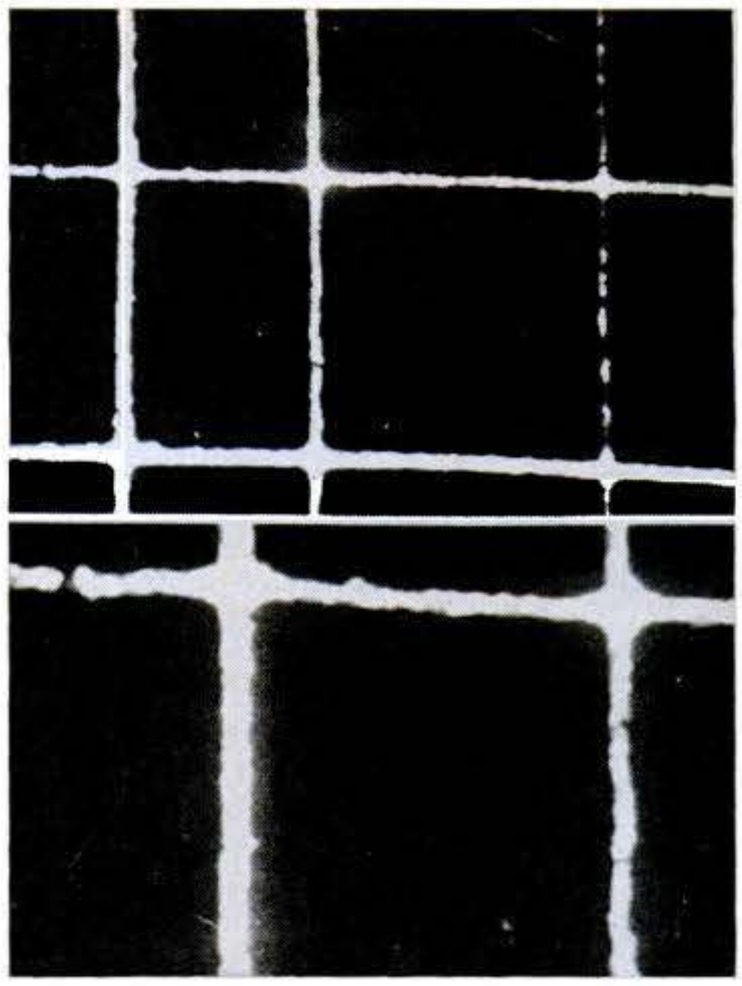
Viking experts are even more puzzled about how some of the other features were formed. One theory is that this terrain (marrain?) has been bizarrely shaped by fierce Martian winds that alternately scour the surface of material and then redeposit it. The linear structures running across the photo may be etched-out volcanic-flow features remaining after a period of surface stripping. The circular objects may be impact craters circled by wind-carried material.

Thinnest metal lines

Metal lines barely tens of atomic diameters wide—by far the thinnest ever made—have been formed by scientists at the Research Division of International Business Machines Corp. in Yorktown Heights, N.Y. The top photo at upper right shows (from left to right) vertical lines that are only 150, 80, and 50 angstroms wide. The bottom photo shows the 150- and 80-angstrom lines enlarged. (An angstrom is 1/100,000,000 centimeter, or about 1/250,000,000 inch.)

One of the exciting possible applications of the ultra-thin lines is the design of X-ray microscopes with focusing lenses. Because the wavelength of X rays is far shorter than that of visible light used in optical microscopes, X-ray microscopes would permit magnifications 25 times higher than now possible in the study of living biological specimens. (Electron microscopes cannot be used to observe living organisms.) The new technique may also allow previously unforeseen experiments into the electronic behavior of semi-conductor materials.

The microfabrication technique works this way: A thin layer of metal, say 100 angstroms thick, is vacuum-deposited on a self-supporting layer of graphite of the same thickness. The metal layer is scanned with an electron beam



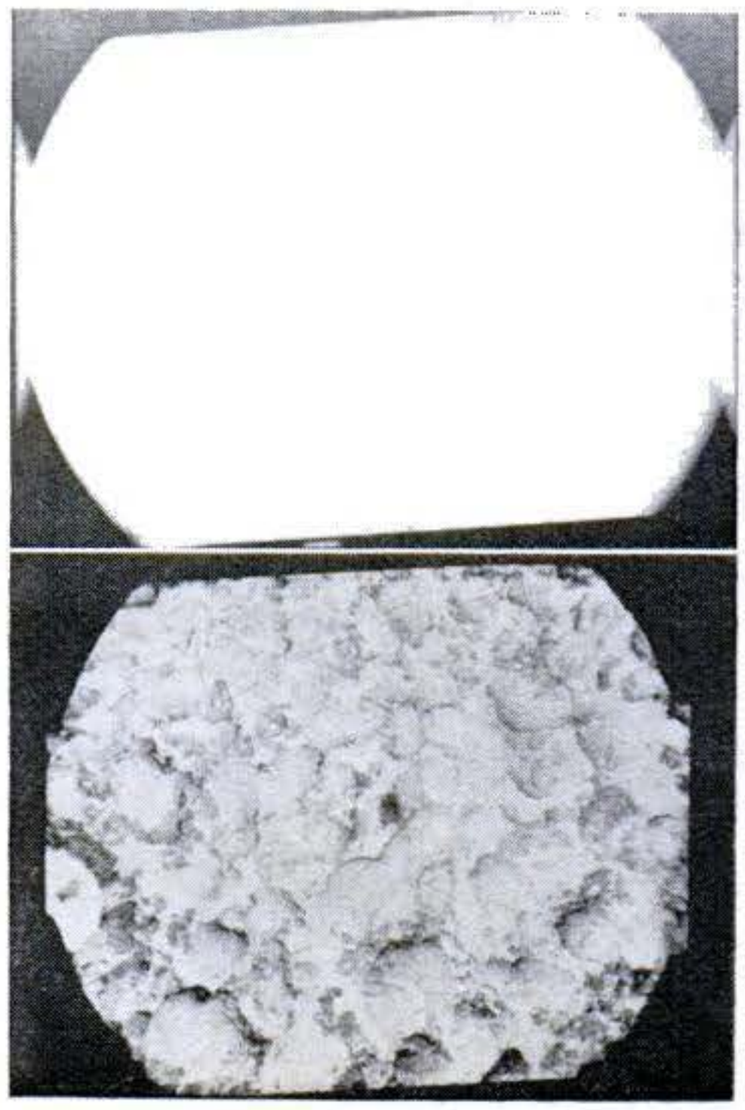
five angstroms wide. Contaminants (those present on the surface from traces of oil and other vapors inside the vacuum apparatus) are polymerized by the electron beam—turned into thin, impervious lines layered over the metal. The tracery of lines left by the beam as it scans the specimen can be monitored on a cathode-ray tube. Then the specimen is put in a sputter-etch device, which removes all of the metal film except that covered by the protective contamination lines.

Eventually, IBM researchers hope to achieve a resolution of 25-angstrom-wide lines spaced only 25 angstroms apart.

Sea-bottom seeing

The photos below demonstrate yet another spinoff of space-program technology into other areas—this time the bottom of the ocean. Computer image processing, created by NASA, has been used to enhance our views of other planets and of the Earth's surface when

Continued



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KOOL'S taste of extra coolness stays smooth and cool, KOOL after KOOL.

Come up to KOOL.

KINGS SUPER LONGS

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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Kings, 17 mg. "tar," 1.3 mg. nicotine; Longs, 18 mg. "tar," 1.3 mg. nicotine, av. per cigarette, FTC Report Dec. '76

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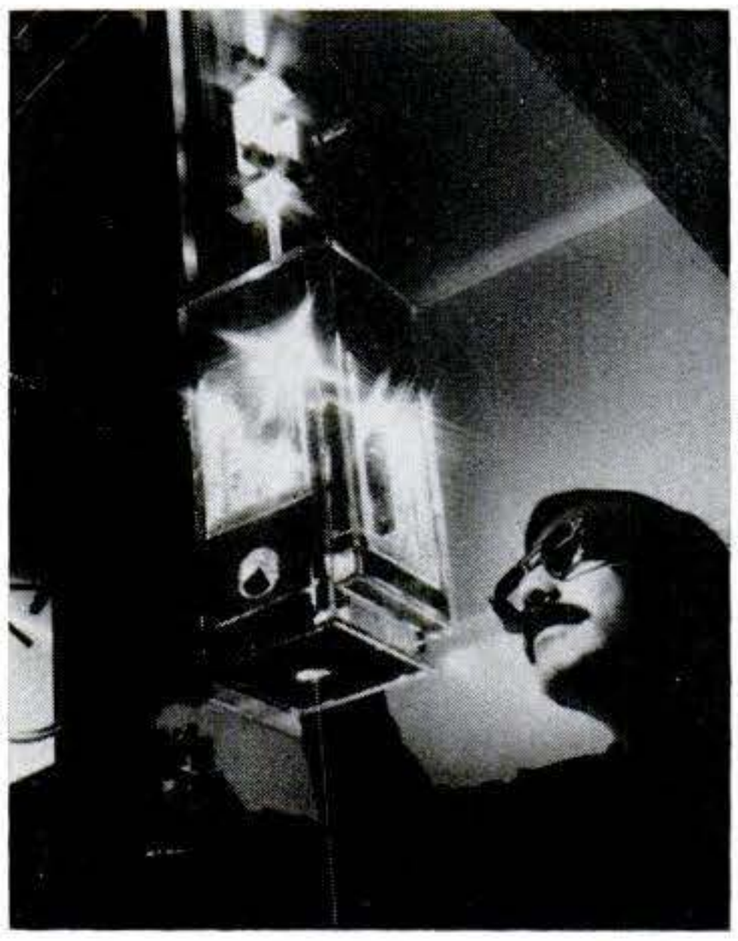
[*Continued*]

viewed from spacecraft. Now it's enabling marine scientists to get a clearer picture of the ocean bottom in their search for mineral resources and for basic knowledge of the ocean's properties. The top photo was made with an underwater camera and strobe light. The special computer enhancement process, developed at Jet Propulsion Laboratory in Pasadena, Calif., turned it into the detailed picture at the bottom.

Superstrength glass fibers



Researchers at Bell Labs have figured out how to make hair-thin glass fibers that are one kilometer long and actually stronger than a stainless-steel wire of the same thickness: The fibers have withstood tensile forces in excess of 600,000 pounds per square inch before breaking. During fabrication, a rod of synthetic silica—the purest glass known—is "fire-polished" with an oxyhydrogen torch to eliminate surface defects. Then a laser beam is focused on the rod, heating and softening it without adding any contaminants. As the rod is softened, a continuous length of ultra-thin fiber is pulled away and immediately given a protective coating. In the photo above, a Bell Labs researcher checks the process.

The advanced technique shows promise for the burgeoning field of optical communications, which will depend on the use of strong, defect-free glass fibers as waveguides for light.

New contact lens

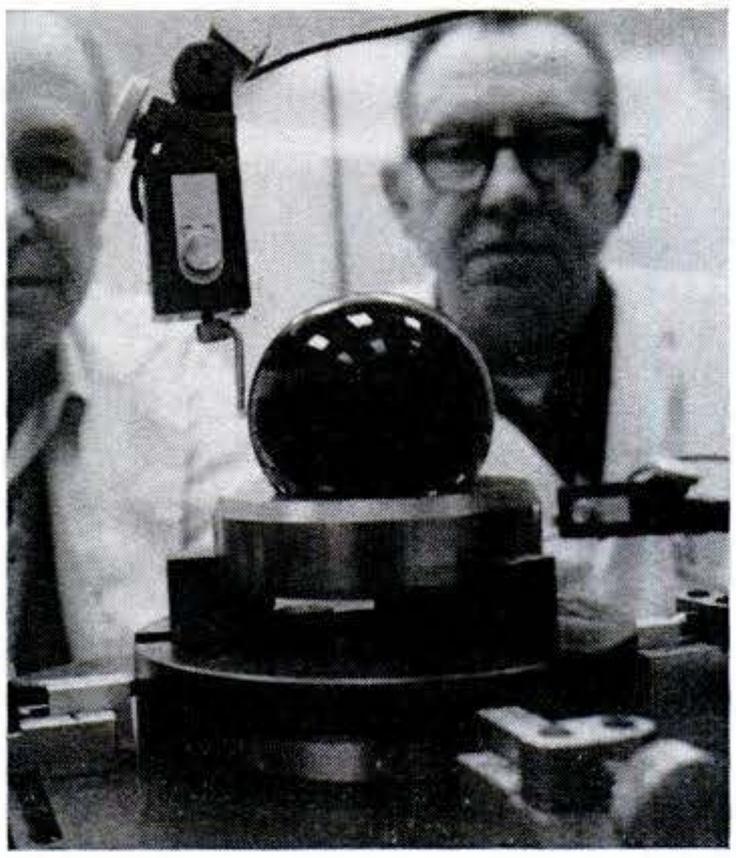
Professor Morton Sarver of the University of California's School of Optometry at Berkeley has announced the development of new materials for contact lenses that may make traditional hard lenses obsolete within a few years. Called gas-permeable hard contacts, they promise longer and more comfortable wearing time, which could make them acceptable to persons who can't get used to the conventional hard contacts. (Persons with visual defects such as astigmatism cannot be fitted for soft lenses.)

The lens Prof. Sarver has been experimenting with combines the Plexiglas material typically used in hard contacts with a derivative of silicone that allows oxygen from the air to pass directly through the lens. One of the chief problems with hard contacts has been the difficulty of getting enough oxygen to the cornea of the eye, with resultant redness, stinging, and swelling in many would-be wearers. In recent tests with the new lens, called Polycon, Prof. Sarver reports, "We had 100 percent success rate in terms of eliminating the swelling" in 46 persons who could not tolerate conventional hard contacts. The Food and Drug Administration must give final approval to the lens before it can be used other than experimentally, so when and if you'll see it is unpredictable.

Patent milestones

At the very end of bicentennial 1976 the U.S. Patent and Trademark Office coincidentally conferred patent number 4,000,000 and plant patent number 4,000. The four millionth U.S. patent is a "Process for Recycling Asphalt-Aggregate Compositions"; the four thousandth plant patent was issued for a Poinsettia plant.

Crystal-ball gazing



The National Bureau of Standards will use this quartz ball as the standard of density: If the density of one pure substance—such as quartz—is accurately known, then the density of all other substances can be referred to it. To be used as a standard the crystal ball has to be made with fantastic precision. Here it is being checked for roundness in an electronic device accurate to 10 millionths of an inch. The ball was manufactured for the NBS by John Pasquin (left) and Jack Reed of NASA's Marshall Spaceflight Center's Materials and Processes Laboratory. PS

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The four-wheel-drive Scout Traveler®, with more cargo space and a heavier payload than Jeep Cherokee.

Eight more cubic feet and 137 more pounds of payload.

Incredible but true!
The new 1977 Scout Traveler gives you more space and more payload than Jeep Cherokee—with a trim, maneuverable design that's a full five inches narrower.

Trimmer outside to maneuver through the tight spots, but more spacious inside, with 103 cubic feet of cargo area to let you take everything along.

Traveler. Chosen "The 1976 Four-Wheel-Drive Vehicle of the Year" by the editors of Four Wheeler and Off-Road magazines. It's beautifully designed to combine rugged off-road performance with highway comfort.

You can order Traveler with a full range of options. From power brakes and power steering to air conditioning and cruise control.

Test drive a four-wheel-drive Scout Traveler. And bring the family along.

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INTERNATIONAL HARVESTER

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LOOK AND LISTEN

By WILLIAM J. HAWKINS

Keep it clean! That's what Pioneer, maker of this CT-F9191 tape deck, says about its recording head—and so do others. Deck makers and tape manufacturers I spoke to agree that the recording head must be kept dirt-free for good-quality recording. What they don't agree on, however, is how often it should be cleaned.

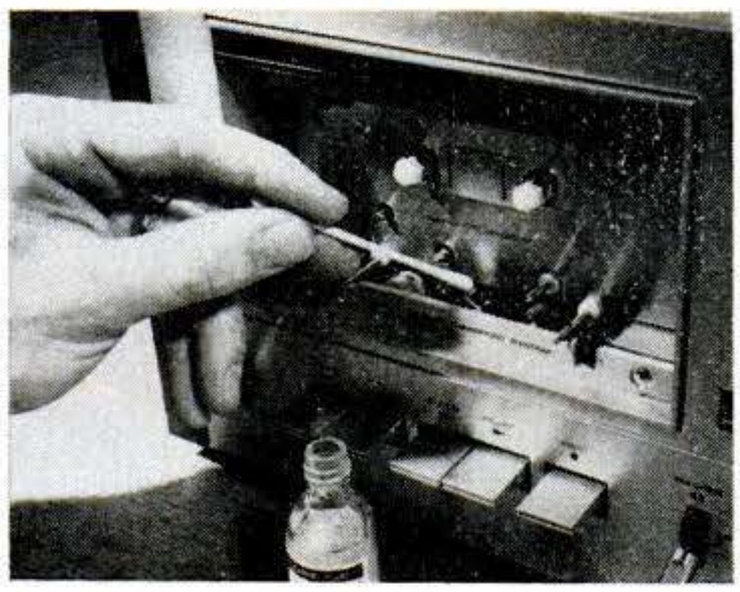
Here's the most logical and useful advice I got: Since 80 to 85 percent of all oxide-shedding occurs during the first two passes, Maxell recommends cleaning the heads after the first eight hours when using virgin tape. On older tape, clean the heads after every 20 hours of play.

What if you don't? You'll not only get poor sound quality, but may ruin the head.

Pioneer's Eastern Service Manager, Fred Ellis, says dirty heads can become scratched after long periods of use. The only fix at that point is to change the heads. For that reason, Pioneer supplies a head-cleaning kit with its deck. And Maxell will supply you with a free booklet on tape and cleaning if you write the firm at Moonachie, N.J. 07074.

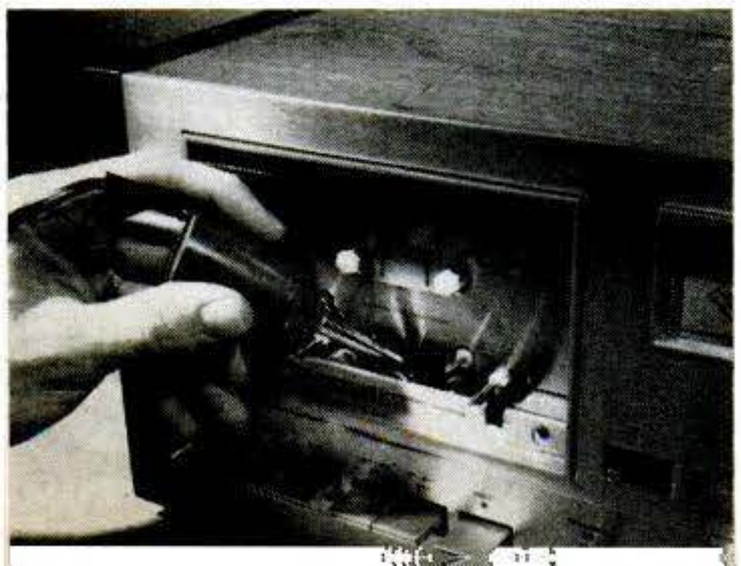
The whole procedure is simple, as shown in the photos; it takes just a few minutes.

Player mechanism should be dusted clean with a lint-free cloth. Do this first so dust particles will be removed during head-cleaning, if they fall there.



Cotton swab, moistened with alcohol or an approved cleaning solution, is rubbed over all tape-contact points: tape guides, all heads, capstan, rubber pinch roller.

Demagnetizer removes the small magnetic buildup on all metallic components that come into contact with the tape. Use it on the heads, guides, and capstan.



Head-cleaning tape can be used between cleaning jobs for extra protection (use it just before making a recording, for example), but not as a substitute.

Legal, schmegal—how about us?

Universal Studios and Walt Disney Productions have recently filed suit against Sony Corp. over its Betamax video recorder. The suit alleges that owners of a Betamax can record off-air movies from the TV and play them back at any time without paying royalties to the movie producer. Universal and Disney want Sony to stop making Betamax machines and retailers to stop selling them.

Unless the suit is dropped entirely, on the grounds that Betamax is for home use only and not for profit, consumers will be caught in the middle. If the courts side with Universal and Disney totally, we won't be able to buy a video recorder at all. That's quite drastic, but another middle-of-the-road decision could come out of this. That decision could make Sony and other video-recorder manufacturers pay a royalty on every machine that is sold.

Sound fair? Not to me. First of all, Sony would have to get the royalty money from somewhere, so tagging it on to the initial cost of the machine and letting the consumer pay for it would be likely. (In a similar suit over audio recorders in Europe, that's exactly what happened.) In addition, what's to prevent national TV networks and other producers from claiming the same infringements, adding more to the price?

After personally using a video-tape recorder for about two years now, I find that I do not save tapes and play them over again or show them to friends. I only use the machine to record shows I ordinarily would miss—hardly a copyright infringement to my way of thinking.

One nagging thought is that Universal is owned by MCA—a company that will soon come out with a home video-disc player. I could understand concerns that video recorders would be in direct competition with a player, and that home copying of discs might possibly cut into disc sales—but the same can be said for audio records, players, and recorders, and they've coexisted nicely for years.

A PS P.S.

If you own a video game, be sure both it and your TV are off at night. The FTC is checking reports that prolonged non-moving images (such as boundary markers) can permanently "burn in" on the face of the TV screen. Another precaution you can take while using the game is to turn down the brightness and add less contrast to eliminate a harsh white-on-black image. Atari's Pong is supposed to be immune because of its automatic moving-light show at game's end. PS

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WHEN YOU BUILD A SPEAKER TO SOUND GREAT ON EVERY PART OF THE MUSIC, YOU CAN'T CUT CORNERS ON ANY PART OF THE SPEAKER.

A single HPM-100 weighs almost 60 pounds.

The fact it weighs more than a Large Advent speaker, Bose 901 or JBL L100 is not an accident.

Our speaker frames are made of heavy cast aluminum instead of the usual stamped metal, so you hear only the speakers vibrating and never their frames.

Our magnets are oversize to spare your ears needless distortion.

And our cabinet is made out of special compressed wood that's denser and heavier than ordinary wood. So the sound is forced out of the cabinet instead of being absorbed by it.

Of course, not everything that adds to the sound of an HPM-100 also adds to its weight.

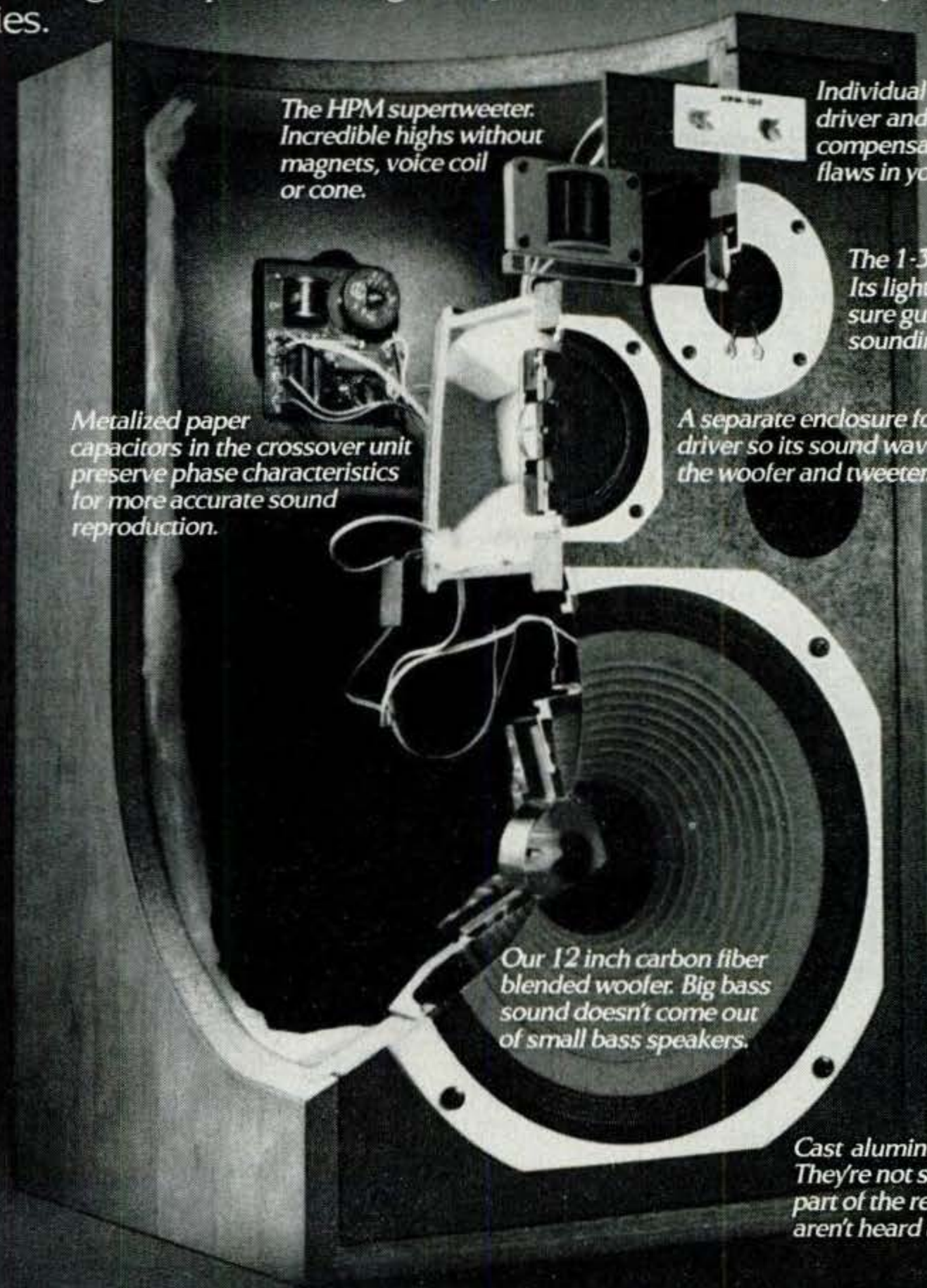
Our supertweeter uses nothing but a piece of High Polymer Molecular film to produce incredibly clear and crisp high frequencies.

Our midrange driver and tweeter have cones that are light enough to give sharp response, but rigid enough not to distort.

And our 12 inch woofer has a long throw voice coil and unique carbon fiber blend cone (instead of the typical cardboard cone) that work to produce the kind of realistic bass you not only hear, but feel.

Naturally, we could go on. About our 12-1/2 feet of damping material. Or about the aluminum screws that keep our speakers from falling out. They're ordinarily used to keep airplanes from falling apart.

But we figure at this point you'd rather hear our speakers in person than hear any more about them from us.



The HPM supertweeter. Incredible highs without magnets, voice coil or cone.

Individual controls for the driver and tweeter. So you can compensate for the acoustic flaws in your living room.

The 1-3/4 inch tweeter. Its light but rigid cone makes sure guitars don't end up sounding like saxophones.

Metalized paper capacitors in the crossover unit preserve phase characteristics for more accurate sound reproduction.

A separate enclosure for the 4 inch driver so its sound waves don't interfere with the woofer and tweeter. Or vice versa.

Our 12 inch carbon fiber blended woofer. Big bass sound doesn't come out of small bass speakers.

Cast aluminum speaker frames. They're not seen too often, which is part of the reason speakers like this aren't heard too often.

HPM-100™
The all-around great speaker.

PIONEER

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DETROIT REPORT

By JIM DUNNE

'Bathtub' Olds and Buick

The 1978 intermediate models will have a fastback roof styling—sometimes referred to as an upside-down bathtub—in both two- and four-door body styles. Cutlass and Century models will be completely new, in size as well as appearance, as they undergo the same shrinking applied to the GM big cars this year. By contrast, Chevelle and Le Mans will have notchback styling, even though they share most underbody and chassis parts with the Century and Cutlass. Notchback styling with deeply recessed backlites will be a styling feature of the 1978 Monte Carlo, another model that uses the intermediate bodies. Monte Carlo will also be about four inches longer than the coupes, with all of the added length in front overhang. Generally, the Chevelle and Le Mans will resemble the current models in styling, whereas Cutlass and Century will look a lot like some European cars, especially Lancia and Dasher.

Ford is concerned

Two nifty new lines are in the works at Ford for 1978, but company officials are worried. Maverick and Comet will be built on a smaller, 105-inch wheelbase, (the 1977 four-door's is 109.9 inches), and that puts them very close to the 108-inch wheelbase planned for GM's new intermediate lines. Ford officials fear that their new compacts may be competing directly against intermediates for the next five years. In addition, Ford has its own intermediates to shrink in future years, and it does not want to make them as small as the GM intermediates, since that part of the market is already covered by the Maverick and Comet. The concern and some confusion is to be expected. Each of the auto companies has its own idea about where its new models will fit into the market, and they dare not consult with competitors. With the sizes of new cars fixed four years ahead of introduction, some overlapping and mismatching is inevitable.

Bronco is still kicking

But the present Ford utility model will be replaced by a completely redesigned vehicle next year. Ford will go along with the industry trend toward a truck-based chassis for the Bronco. That means the 1978 model will be bigger, and will be built with the pickup-truck cab and front sheet metal. It will also mean better availability of replacement parts, since the Bronco will have many parts in common with the pickup. Bronco's engine lineup will be expanded, with a six-cylinder and at least one V8 to be available. With the switch to the bigger chassis, the possibility of a diesel engine also becomes real.

Ford wants overdrive automatic

At least the company is preparing for a four-speed automatic that will be used with V8 engines in Ford's bigger cars of the future. Until now, Ford has used only a three-speed automatic, a design that is standard in the industry. The fourth gear in the new transmission will have an overdrive ratio and give the car a potential 15-percent increase in fuel economy. The transmission is needed to keep the big cars of the 1980's abreast of fuel-economy laws enacted by Congress. By 1985, under these statutes, the average economy of an automobile manufacturer's lineup must be 27.5 mpg. While big cars need not reach that figure, any boost they can manage will help the average.

Front-drive size

General Motors is already making preparations for fitting engines into its 1979 front-drive compact. Only four-cylinder inline and six-cylinder V types will be used, but they have to be altered to fit in a crosswise position. Slated for installation on the 1979 Nova, Ventura, Omega, and Skylark are the Pontiac 151-cu.-in. four, the 231-cu.-in. Buick V6, and a new V6 from Chevrolet. Some variations on these engines that will provide a choice of power plants in each car are also on the way. The Buick turbocharged V6 is one. To fit the engines inside the hood, GM engineers will redesign the intake and exhaust manifold, reposition motor mounts, and relocate the cooling fan. Performance and fuel economy, however, will be comparable to present designs.

Chevy getting two V6's

The V6 engine holds great promise at GM. Chevrolet is preparing two different V6's for future use. One, to be introduced next year on Chevy Nova and larger cars, will be built for conventional-drive autos. With a 90-degree angle between banks of cylinders, it will be used in front-engine, rear-drive cars. The other—not quite so far along in development—is a 60-degree design that will work well with the front-drive cars Chevy has planned for 1979 and beyond.

The advantage of the 60-degree design is in its outside dimensions: It's narrower, takes up less room under the hood than the 90-degree engine, so can be installed in smaller cars. It is especially well suited to front-drive cars where the engine is installed crosswise and underhood space is crowded by the transmission and final-drive system. V6 engines in general are compact, and offer higher performance than fours, but better economy than V8's.

Plastic cars nearer

Except for the Corvette, no high-production plastic car is available to American buyers. But that will change dramatically in coming years as the auto makers switch to lightweight plastic panels and systems to replace heavier metal parts. In the 1978 Chevy and Pontiac intermediates, plastic front ends of the soft-nose type will replace separate steel bumpers and grilles. Plastic suppliers are eyeing other parts too, including wheels, wheel covers, door panels, fenders, deck lids, seats, fuel tank, and roof. But it won't happen overnight. There is not enough plastic in the world to fill all possible automotive applications. What we'll see are spot applications of plastic on different models. Look to GM to lead the way: It has the most extensive background in plastic, and shows boldness in building massive plastic parts to replace traditional metal ones.

Lights are shaping up

Those rectangular headlights you see on European cars are now legal in the U.S., and they'll be showing up on the GM intermediate-size models for 1978. This will signal the end of the popularity of single round headlights, because the boxy look of the lens harmonizes with the new angular grilles and sheer body panels. Three years ago, dual rectangular headlights made their debut on GM lines, and they have since appeared on Ford and Chrysler models.

The single rectangular lamps should be even more popular, and may show up eventually on the majority of small cars built in this country. Backers of the rectangular lights claim that they throw a more precise light pattern while cutting down on the height of the lamp, thus permitting lower hood lines and increased visibility. The most important reason for going to rectangular lamps is appearance, though; those other reasons are mere rationalizations. Shape, size, and candlepower of headlamps are controlled by the federal government, which for three decades has resisted the addition of more headlight systems in order to ease inventories and make replacement units cheap and readily available. PS

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People write to PENNZOIL

Supreme Quality — Safe Lubrication

Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Diesel Dirt. After a few hundred miles in my diesel-fueled car, the crankcase oil (Pennzoil) turns quite black. Using a microscope, I looked at some used oil and found small, well-dispersed particles. Are these particles harmful to the lubrication properties of your oil? Why does the oil in this engine discolor so rapidly?

R.O.O., Prince Albert, Saskatchewan, Canada

The particles you saw are fuel soot and unburned fuel resins, the normal by-products of diesel combustion, which are too small for the filter to remove. These carbonaceous particles cause crankcase oil in diesel engines to discolor rapidly but will not harm the engine unless they have built up to an excessive level. The fact that the particles are well-dispersed indicates that the detergent/dispersant additive in the oil is doing its job. To avoid a buildup, it's important that you maintain oil drain periods consistent with operating conditions.

Diesel Advice. Is Pennzoil Multi-Duty Series 3 the most satisfactory motor oil for a Series 240D Mercedes with a diesel-fueled engine? If not, what do you advise?

A.H.F., Kittery, Maine

Rather than Series 3, we recommend Pennzoil Z-7 Motor Oil in the SAE grade recommended by Mercedes for the temperatures you encounter.

Oil Guzzler. I purchased a '72 Chevy when it was new and now it has 108,000 miles on the clock. When it hit 100,000, I flushed the engine with a product that is supposed to clean. Now, although the car still runs well, it uses a quart of oil every 500 miles and the tailpipe has begun to turn black for the first time. What have I done? The car has had no major problems before now and I intend to keep it for another 100,000 miles. (I've always used SAE 20W-20).

R.M.C., Thomson, Georgia

By flushing your engine it looks as though you've removed engine deposits thus creating increased piston ring-piston wall clearance. This allows excessive oil into the combustion chamber which is eventually burned. We recommend you try a heavier oil such as Pennzoil 20W-50 with Z-7. If that doesn't lower oil consumption, an overhaul might be in order.

Leaky Rear Seal. A few weeks ago I decided to replace the rear-end lubricant in my Duster with 90,000 miles on it. About a week later, I noticed the front seal on the differential (where the drive shaft goes in) began to leak for the first time. What could make this happen?

H.C.H., Oregon, Wisconsin

First, you mustn't overlook the fact that a differential seal with 90,000 miles of service can be just plain worn out. Second, it's possible you overfilled the differential with lubricant, which causes foaming that generates pressure resulting in oil being forced out around the seal, especially if the air vent in the differential housing is plugged or clogged.

Far-Off or Right-On? I have a chain saw, snowmobile and outboard motor. They all call for a 2-cycle SAE 30 oil mixed with gas. How far off would I be if I used SAE 30 Pennzoil Motor Oil in all of them?

R.R., Pittsfield, Maine

You'd be real far off! Automotive engine oils are not recommended for gasoline mixtures or use in 2-cycle engines. You could use Pennzoil All-Purpose 2-Cycle 50 to 1 Oil in all three of your 2-cycle engines.

Hot Stuff. At 87,000 miles my timing gear went out which caused a few bent push rods and valves. When repairing them I noticed something I'd never seen before. On several of the rocker arm bolts and some other non-moving parts in my engine there was a thin layer of varnish which I could flake off with my fingernail. Everything else under the valve covers was clean as a whistle and there wasn't a teaspoon of sludge under either valve cover. The oil was changed every 1,500 miles. What could cause this varnish build-up?

A.D., San Diego, California

The main cause of varnish is high operating temperatures. Normally, the varnish you describe does not affect engine performance since usually it forms only in the rocker arm cover because temperatures are higher there and there is no oil circulating to cool the surfaces. Some of this varnish is also due to fuel dilution vapors which rise to this area from the crankcase.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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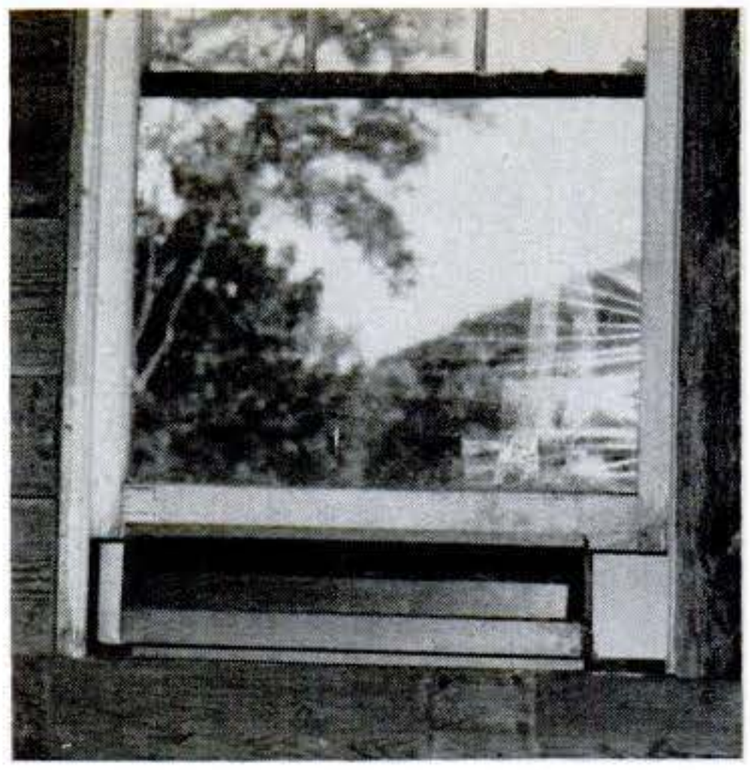
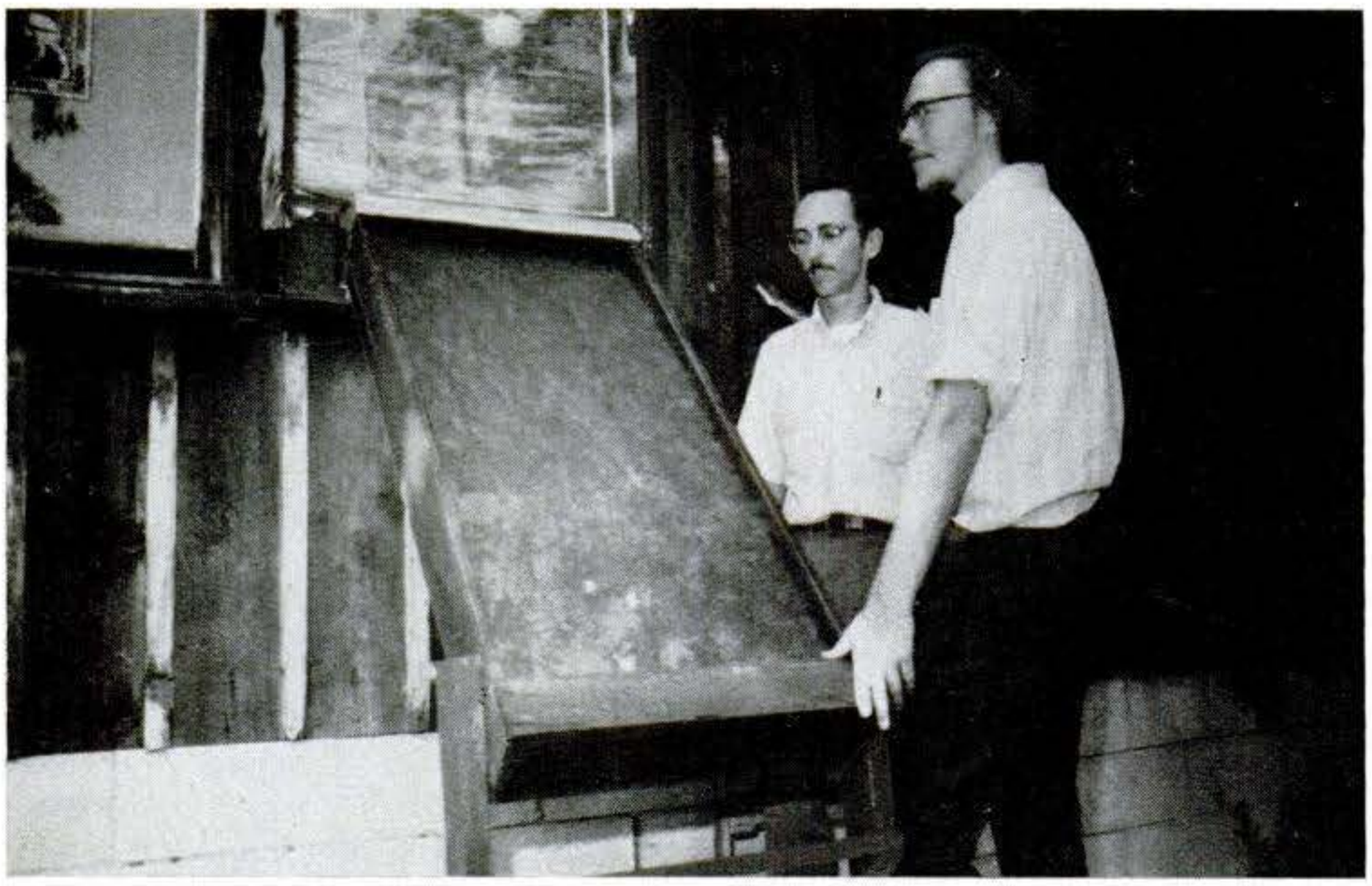
ADVENTURES IN ALTERNATE ENERGY

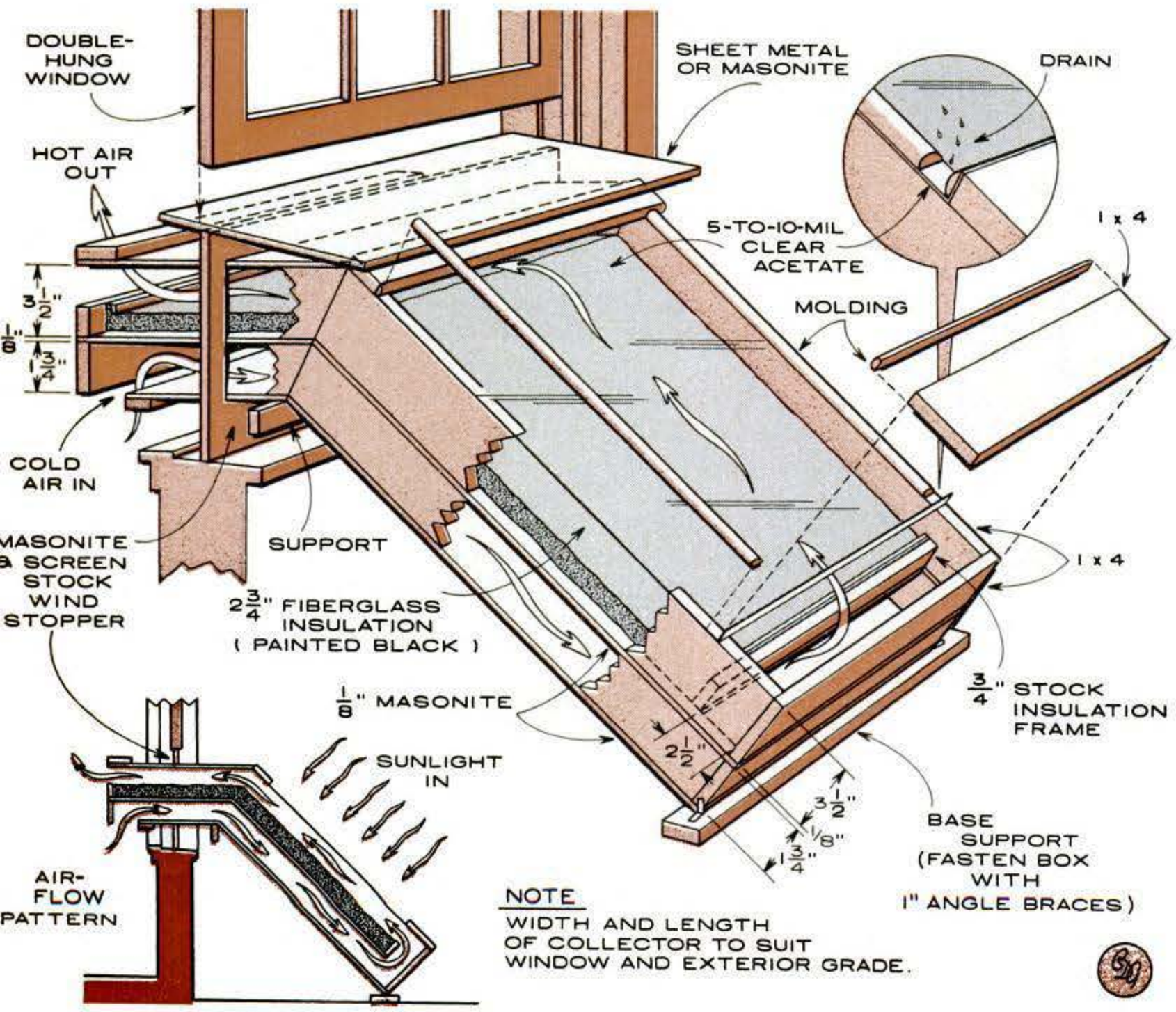
A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Bill Rankins and David Wilson: Solar window





Collector attaches to existing sill; it's supported by specially built frame—or by roof below upstairs window. View from window (photo, upper right) is not appreciably impaired. You can even adapt the device for a storm window.



By EDWARD MORAN

This month's energy project is a natural for the do-it-yourselfer who would prefer to experiment with a basic solar device before tackling some of the complete systems featured here in previous months.

A solar window requires neither an ERDA contract nor a master plumber. It is easily assembled on a Saturday afternoon, and is an ideal heating supplement for locations that don't permit a permanent array of rooftop collectors—apartment houses, for example.

There's no provision for heat storage, so the window is useful only as a daytime supplement, but outlet temperatures on sunny days average between 100 and 120°, report Bill Rankins and David Wilson. Air is circulated through the unit by natural convection, although blower, thermostat, or automatic dampers could be added.

The air-flow diagram (lower left) shows how cool air is heated in the insulated "tongue" of the collector, then rises through the lip into the house. The collector automatically pulls in colder air to replace it. "If you use a fan to force-feed the air through the collector," says Wilson, "you will move a greater quantity of air, but will have a lower temperature provided by the heating process."

Site planning

As with any collector, the solar window must be oriented to take full advantage of the sun. The window that receives the most sunshine most of the time is the obvious candidate, but because of the "portability" of the solar window, you could install several of them, to capture more sunlight. Furthermore, by adjusting the base support, you could adapt the collector to seasonal angles of solar inci-

Continued

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Now you can step up to an Olds priced under $5,000.

Even good gas economy comes standard.

OMEGA: The Looks.

Who says an "economy" car has to look like an economy car? This one's an Oldsmobile—and looks it!

The Price: $4,194*

Makes a lot of "economy" cars look over-priced.

The Mileage: 26 mpg highway, 19 city.

EPA estimates with standard 231 V-6 and available automatic transmission. EPA estimates are lower in California. Your mileage will vary depending on how you drive, your car's condition, and its equipment.

The Equipment You Want.

The price shown includes automatic transmission, AM radio, belted bias-ply whitewall tires, body side striping and chrome wheel discs.

CUTLASS S: The Looks.

Cutlass style and Cutlass comfort—with your choice of cloth or vinyl-trimmed seats.

The Price: $4,811*

Making this the most affordable Cutlass going.

The Mileage: 25 mpg highway, 17 city.

EPA estimates with standard 231 V-6 and available automatic transmission. EPA estimates are lower in California. Your mileage will vary depending on how you drive, your car's condition, and its equipment.

The Equipment You Want.

The price shown includes automatic transmission, AM radio, glass-belted radial whitewall tires, body side striping and chrome wheel discs.

*Manufacturer's suggested retail price, including dealer preparation. Tax, license, destination charges, and other available equipment additional.

Oldsmobile

Can we build one for you?

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[*Continued*]

dence without too much difficulty. The unit can be anchored to the ground, installed in a second-story window over a porch roof, or attached to a shelf, as a window air conditioner would be.

Assembly details

Actual dimensions will vary, of course, depending on each window sash, but the thickness of insulation and glazing given here has worked well for Rankins and Wilson. Before you start to assemble the collector, paint all wood parts (both sides) with two coats of outdoor paint or spar varnish. Make a "box" first, by cutting 1x4's at a 67½° angle and making a "hockey stick" by attaching the two pieces with a sheet-metal strip. Add the top lip and nail on the bottom hardboard sheet, plus the end piece.

Make another assembly just like the first; when the two are piggybacked and fastened together, the two air-circulation channels will be created (see diagram). In effect, this puts the heat-absorbing surface on a ⅛″ hardboard sheet that is fixed 1¾″ over the hardboard bottom (creating the lower cold-air channel). Rankins and Wilson use a 23″-wide section of 2¾″ fiberglass insulation batt, with its kraft-paper backing painted black. They secured this batt at each end with screen mold and ¾″ nails. If you have an unfaced batt, you can cover the fiberglass with a thin sheet of metal and paint that black.

Complete the assembly as shown in the drawing. Seal edges between the hardboard and the screen stock with duct tape on the outside. Glass could be used as a cover material, but Rankins and Wilson decided to use five- to 10-mil acetate since it was less expensive and easier to work with. They pulled it tight and tacked it down under the screen mold with ¾″ nails, then trimmed off excess. For a tight rain seal, they advise varnishing the wood before nailing, and caulking afterwards. Moisture in the collector will be evaporated by the sun, and will pass into your house as excess humidity.

An added bonus: When the wind blows, the plastic cover ripples slightly, creating a "natural pump" to move the air through the collector, says Wilson.

Installing the collector

When you install the collector in the window, the hot-air outlet to the room *must* be either horizontal or pitched upwards for proper air flow. Add a rain cover, and seal any leaks between collector and frame with duct tape and insulation. To prevent reverse convection at night or on cloudy days, make two snug-fitting wood doors, to plug up the intake and outlet. If you are mounting the collector on a roof beneath a window, bolt it with angle braces; any hole can be quickly repatched with tar if the collector is moved elsewhere.

Variations are possible. For example, Wilson suggests using an elongated version of the collector to link a basement window with a ground-floor window.

Rankins and Wilson have written and published two books on do-it-yourself solar projects, complete with many illustrations and dimensioned diagrams. For a price list, or to ask a specific question about the solar window, send a stamped return envelope to them c/o Lorien House, P.O. Box 1112, Black Mountain, N.C. 28711. PS

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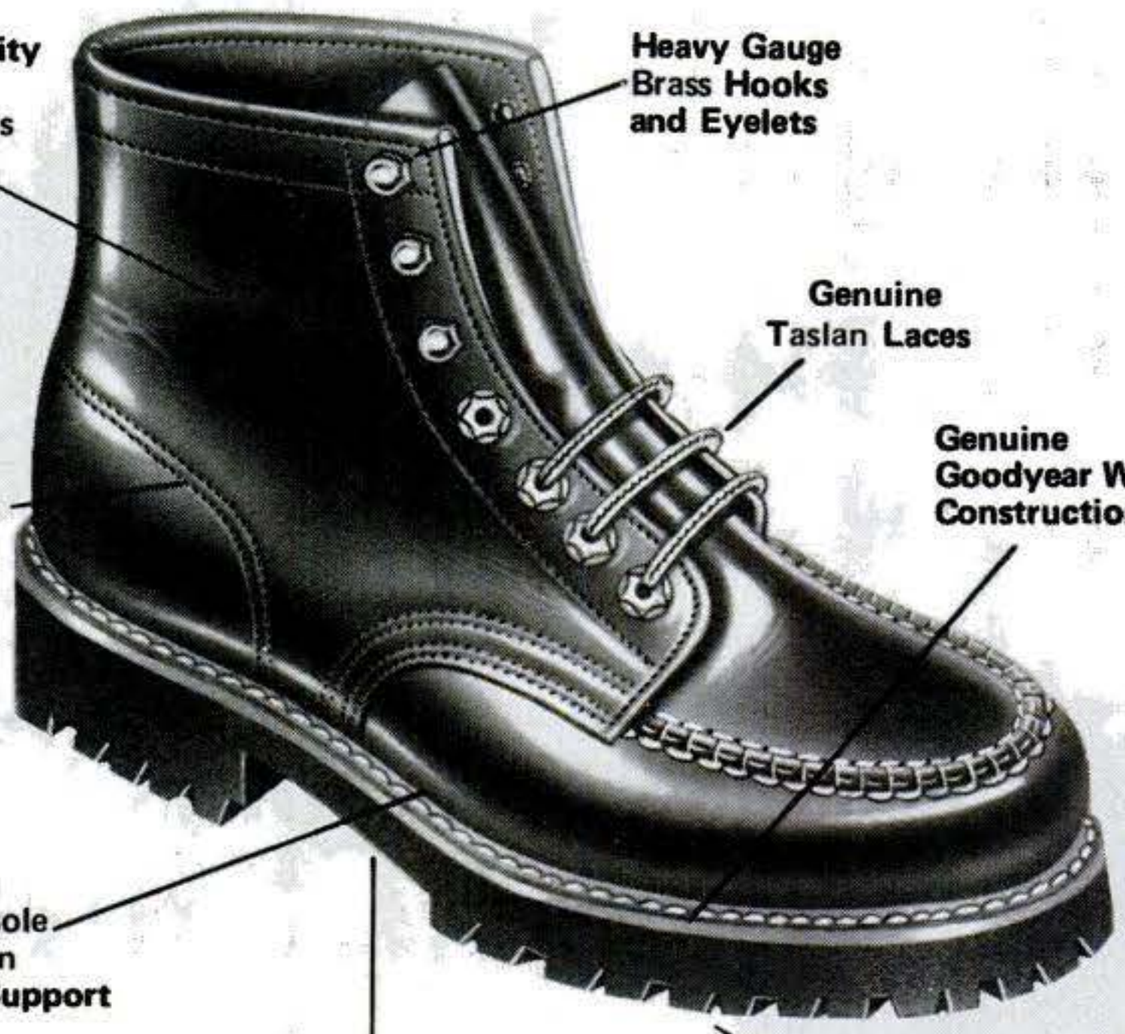

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Each month, we'll present a project developed by a PS reader and pay the inventor $200. Ideas not suitable for this series might be purchased at regular rates for use elsewhere in the magazine.

To enter, send us black-and-white glossies (one photo should show you demonstrating your device) plus pertinent text and sketches. Write your name, address, and Social Security number on each item. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers, if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017.

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SP4 William S. Morgan, 8th Infantry Division, Baumholder, Germany

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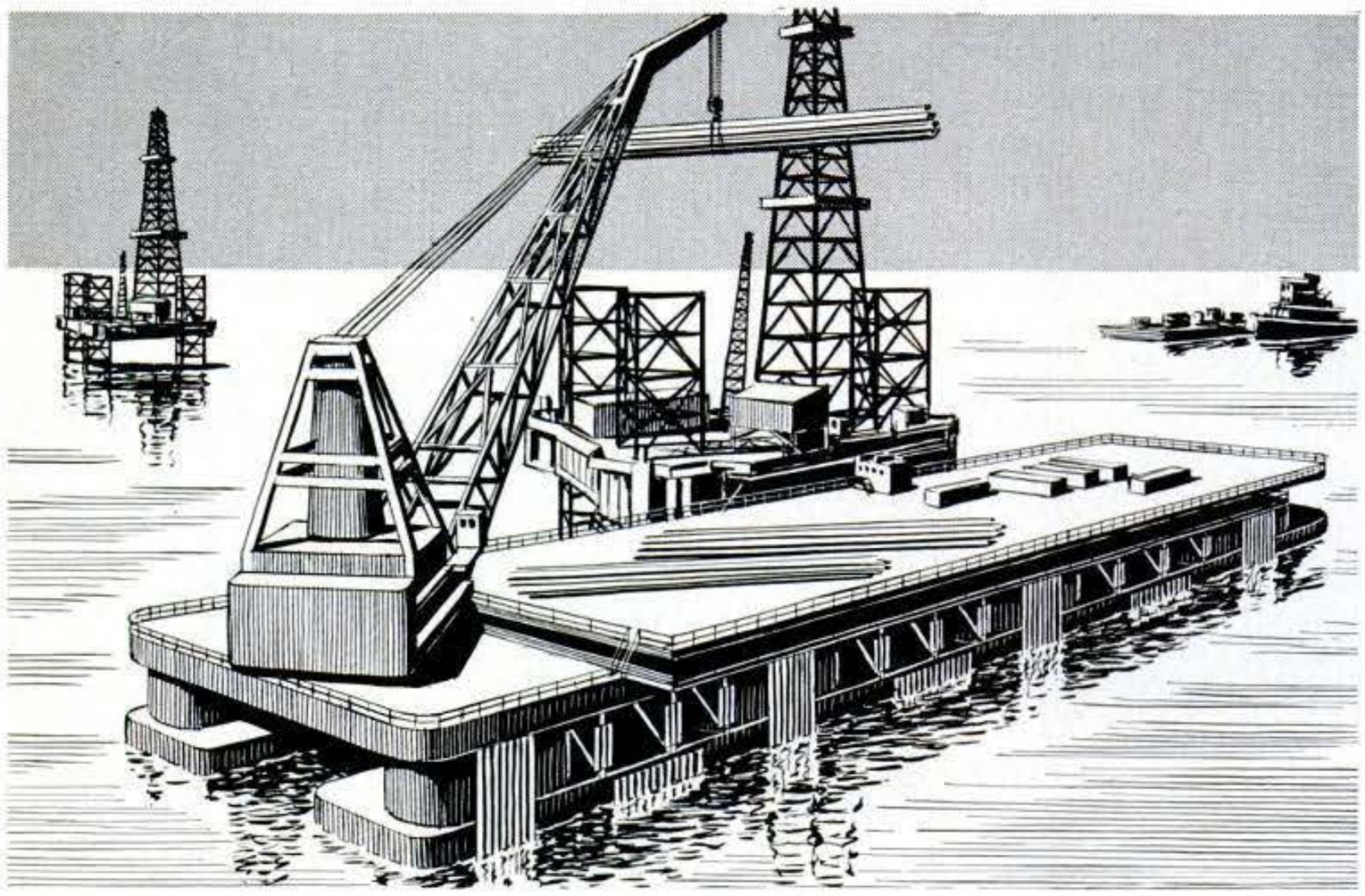
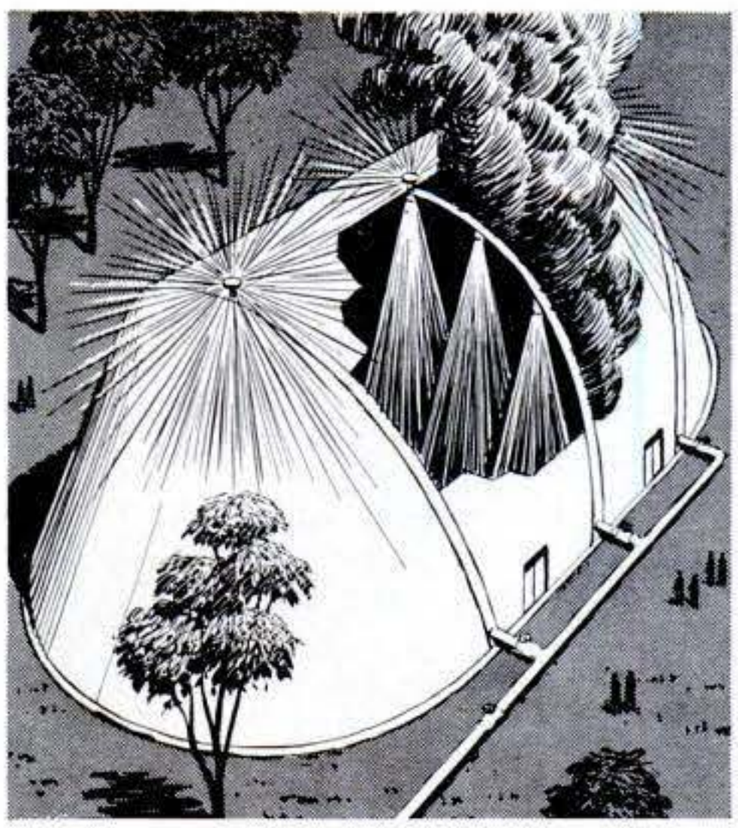
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY RAY PIOCH



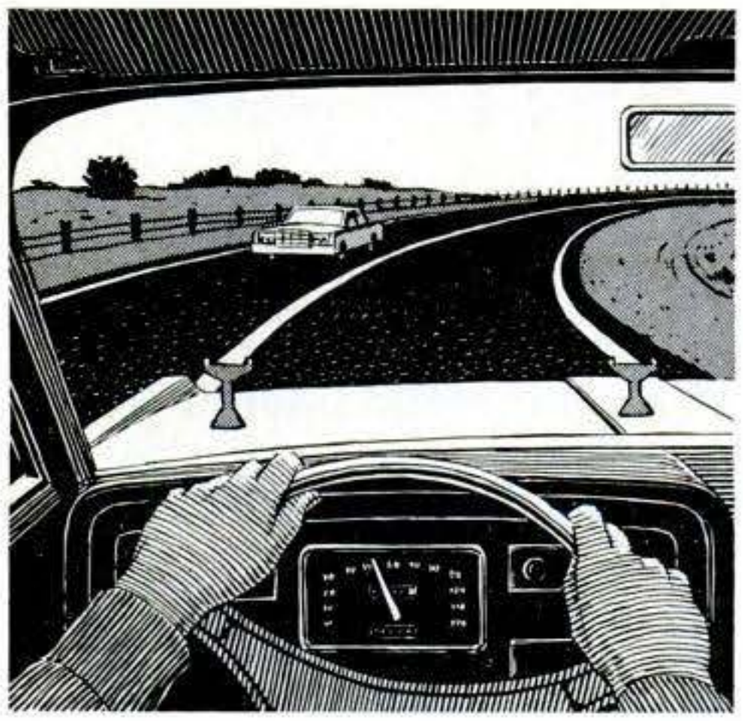
Ballasted derrick barge steadies crane in rough seas

The twin hulls of this semisubmersible offshore derrick barge are ballasted so the whole structure can float higher or lower in the water. When they are partially submerged, the stabilizing columns supporting the derrick platform minimize roll and pitch by resisting motion through water. By raising or lowering the hulls, an operator can compensate for varying wave and sea states, permitting work even when wave heights considerably exceed six feet.



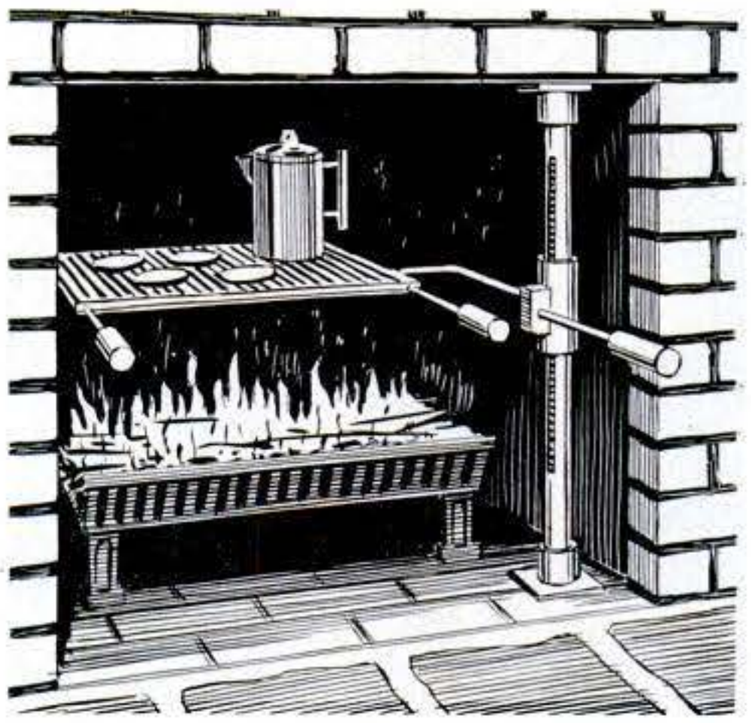
Dome's arches quench fires

Plastic-covered shells and domes—used as sports arenas, meeting halls, storage sheds and the like—have sometimes proved dangerous when fire caused plastic membranes to flare up very quickly. This inventor would form some or all of the supporting arches out of watertight tubes connected to a high-pressure main. Heat sensors would turn the supports into sprinklers.



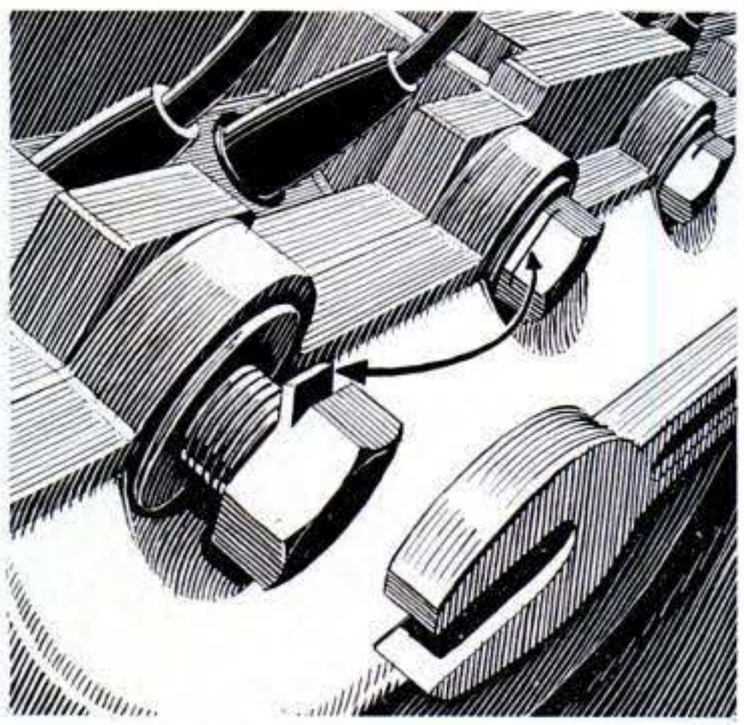
Sights follow lane stripes

Fastened to a hood or fender by screws or suction cups (or to a windshield by an adhesive), these notched or slotted guides might help you to lock in visually on painted lane markers and follow them more easily around curves. Like much-enlarged target sights, they'd draw a bead between your normal driving position and a distant lane stripe.



Rack turns fireplace into grill

Mounted on a spring-tensioned upright, this grill would ride up and down on its own rack and pinion, and would tilt or swing out as you moved its extended, bare-hand controls. You could lower the rack for barbecuing, raise it for gentle warming. Attached to a basket grate, the assembly could also be used with an outdoor grill.



Bolt-head slit gauges torque

This slit would be formed without removing any metal. When it was tightened (with an ordinary wrench), closure of the slit would show it was under the right amount of stress. It's said to be better than a torque-wrench setting because no allowance need be made for frictional differences between bolt and surface metals.

The following patents have been issued on these inventions: **Ballasted barge**—No. 3,835,800 to S. Lloyd, III, Mill Valley, Calif., and Y. Goren, Los Angeles; **Lane sight**—No. 3,834,036 to F. Scarritt, Sr., St. Petersburg, Fla.; **Grill**—No. 3,834,370 to J. Nelson, Stoughton, Wisc.; **Dome arches**—No. 3,837,405 to C. Huddle, Pleasant Ridge, Mich.; **Bolt slit gauge**—No. 3,834,269 to Jack G. Ohringer, San Francisco, California.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

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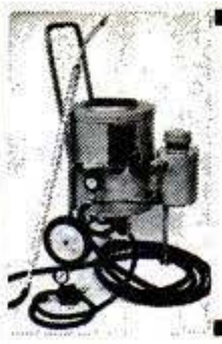

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Jumbo loading ramp
flies anywhere

Loading 10 2½-ton army trucks onto a 747 jumbo can be an oversized problem—especially in military operations, where speed and efficiency are critical. An air-transportable loading ramp, currently being tested by the Boeing Aerospace Co., promises to help solve such weighty problems.

The unique ramp, Boeing reports, permits drive-on/drive-off operations (conventional ramps use a forklift method). Deployment requires four simple steps: First, the cargo powerdrive of the 747 pushes the ramp through the open nose of the plane to its halfway point. Powered by a built-in hydraulic system, the ramp jacknifes in the middle until the wheels on the front end touch the ground. The rest of the ramp is then moved forward until it can be attached to the sill of the plane. Finally, the jackknifed ramp is straightened until it forms a 20-degree angle with the ground. Total time: eight minutes.

Made of aluminum, the ramp is 43 ft. long, weighs 14,000 lb., and has rubber flop-up rollers that allow pallets to be winched into the aircraft easily. When the toe ramps at the foot of the loader are in the down position, drive-on/off operations can take place.

The ramp can either be retracted into the plane and transported for use elsewhere, or it can be left on the ground for swift repositioning onto other aircraft.

A crew of three is required to operate the ramp. One controls the hydraulic system, and two assistants attach and remove the safety cables.

The Air Force is expected to make a decision on its Advanced Tanker Cargo Aircraft (ATCO) this spring, and if the 747—a major contender—is chosen, Boeing plans to offer the ramp as an option on the air-craft.—*Elizabeth Bendall*

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The manufacturer's suggested retail price for a stick shift, six-cylinder† Dodge D100 pickup is $3944*; with V8 engine, $4061.* That's lower than Chevy or Ford.

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LOWEST PRICED FOUR-WHEEL-DRIVE PICKUPS.

The Dodge W100 Power Wagon with six-cylinder engine† and four-wheel drive has a suggested retail price of $4985.* That's lower than Chevy, Ford, or Jeep.

LOWEST PRICED CLUB CAB PICKUPS.

The Dodge D100 Club Cab with six-cylinder engine and manual transmission† has a suggested retail price of $4241.* That's lower than Ford. (Chevy doesn't even make a Club Cab.)

'77 EPA ESTIMATES: 24 MPG, HWY. 18 MPG, CITY.

That's for Dodge D100 conventional cab pickups with a standard 225 Six engine and manual transmission.† Your actual mileage may differ, depending on how and where you drive, the condition of your vehicle and its optional equipment. Dodge's exclusive four-speed overdrive transmission† is also available as an option to help improve fuel economy.

TOUGH ENOUGH TO CARRY BIGGER PAYLOADS.

Dodge D100 is built tough enough to carry a bigger payload than comparable Chevys and Fords.

NOBODY BEATS DODGE FOR LONGEVITY.

97 percent of Dodge trucks built in the last sixteen years are still on the job. That's the highest percentage in the business. (Source: R. L. Polk 1975.) It all adds up to one heck of a tough pickup you can buy or lease... by the truck or by the fleet.

DODGE TRUCKS HAVE GOT IT WHERE IT (REALLY) COUNTS.

*Price and price comparisons based on manufacturers' suggested retail prices, not including destination charges, taxes, and options. California prices slightly higher. †N/A in California or high altitude areas. △N/A in high altitude areas.

Dodge Trucks

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Versatile vans

–station wagon, truck, camper all rolled into one

Test vans, front to rear, are Ford E150 Cruising Van, Chevy G20 Caravan, and Dodge B200 Street Van. All three are available with either a short or long wheelbase. Trim options range from spartan to fancy; interior trim and carpeting reduce noise levels considerably. Ford's exterior is fanciest.

By JIM DUNNE and RAY HILL

A van can be just about anything you want it to be—a workhorse truck, a station wagon, or a camper to haul your family and camping gear (and maybe a dirt bike or two) away for a weekend of relaxation. You can't find this kind of versatility in any other vehicle.

That's why van sales climbed to 500,000 last year. And this year Detroit expects to sell over 600,000—four times as many as were sold in 1970. Why the dramatic increase? The answer is one word—

Continued

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Ford	Chevy	Dodge
Fuel economy	0	0	0
Acceleration	5	5	5
Braking	1	3	3
Handling	1	1	2
Maneuverability	3	2	3
Ride comfort	3	3	3
Quietness	1	0	0
Roominess*	4	4	4
Visibility	0	0	0
Entry/exit ease	2	2	3

*Two front bucket seats only

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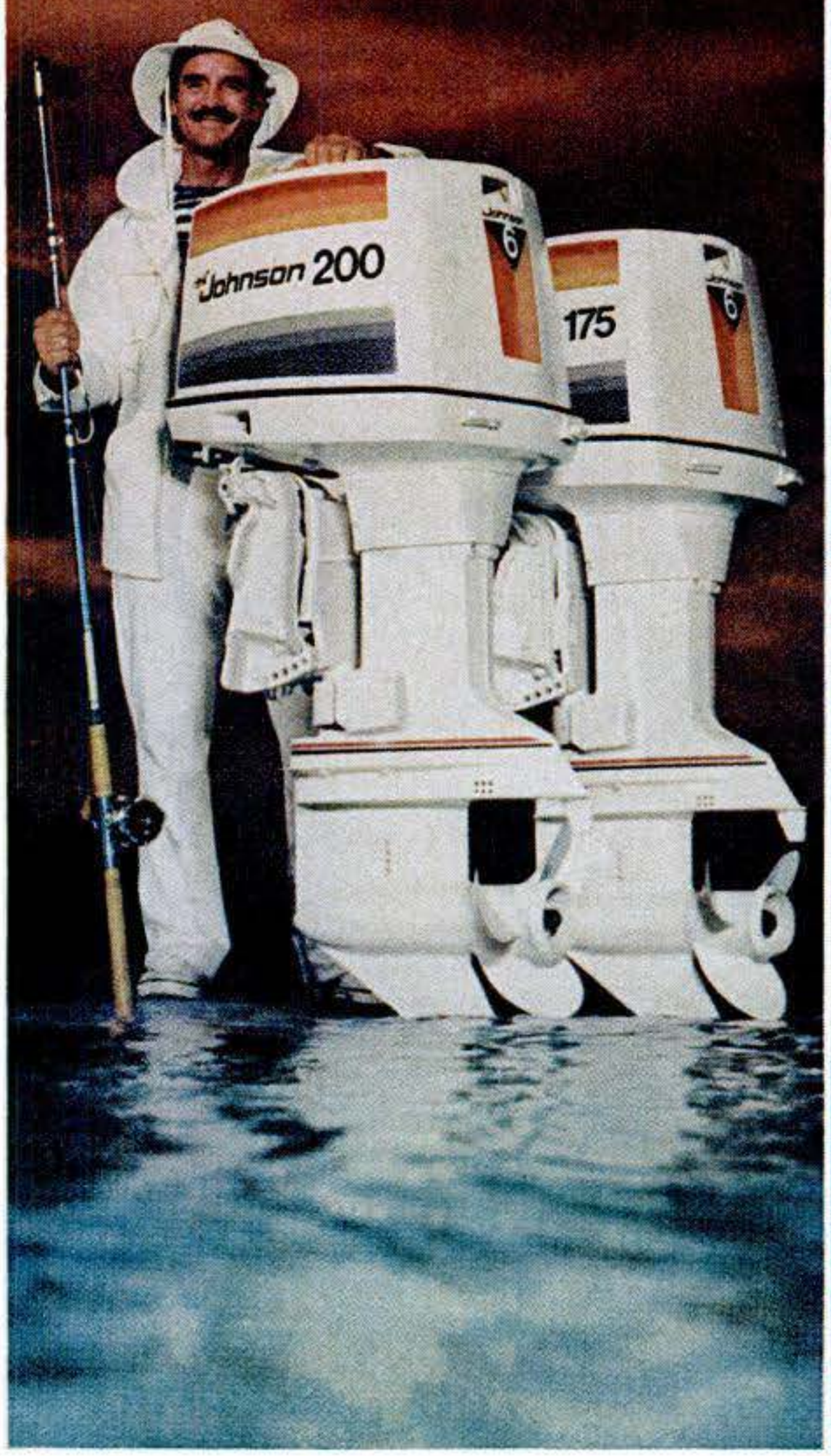
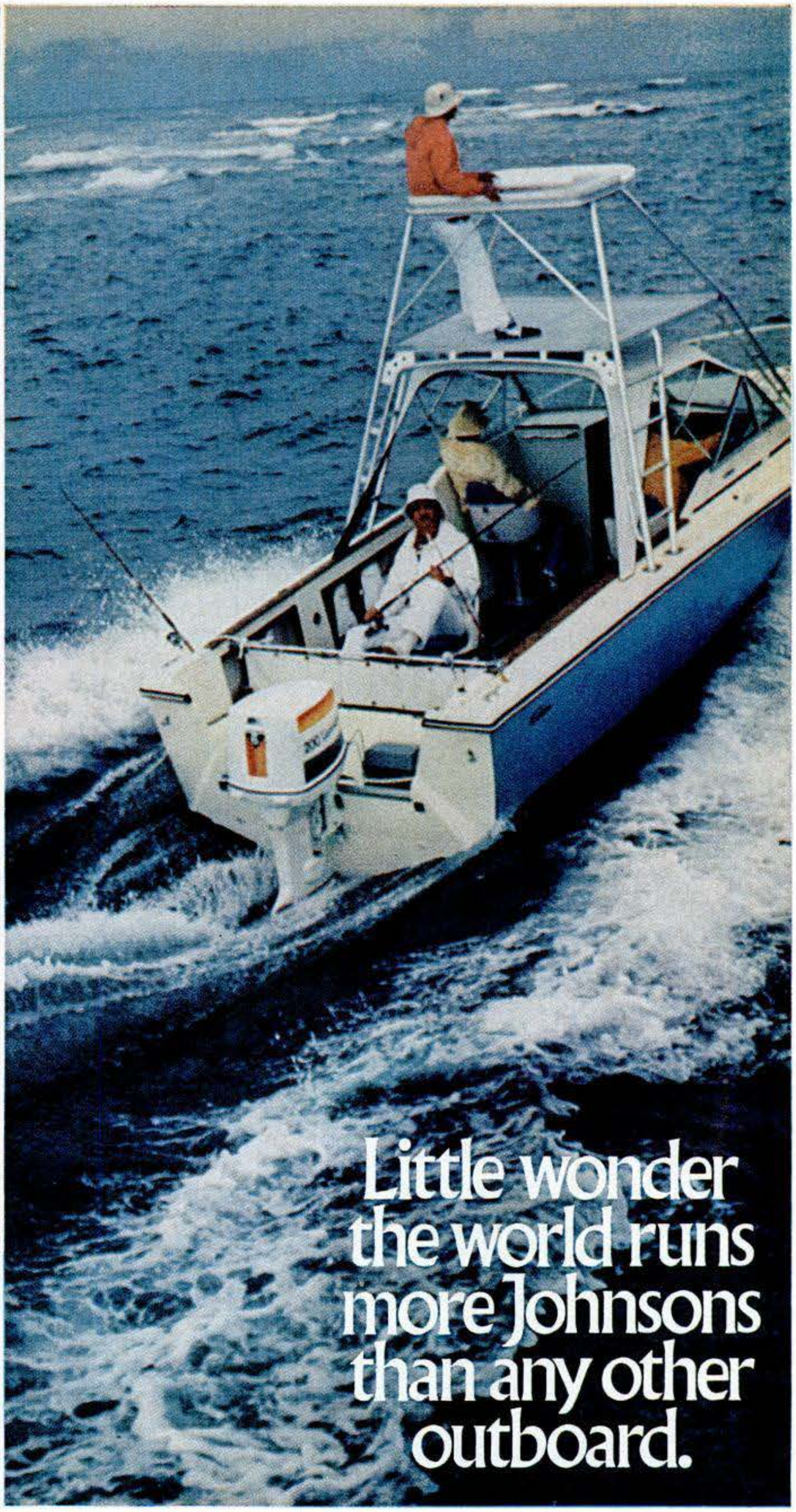
Johnson's V-6s. You're looking at the world's most powerful outboards.





Little wonder the world runs more Johnsons than any other outboard.

Last year, our 200 hp V-6 was a giant step forward in outboard performance for big offshore cruisers and muscle boats. So this year we've added a 175 hp version for more boaters to step up to V-6 performance.

Performance starts with a full 90° V-6 design that provides a barrel-chested 149.4 cubic inches. So the engine gives you outstanding thrust for getting on plane fast...doesn't have to breathe hard to let you cruise faster at a fuel-efficient, part-throttle setting than smaller motors pushing comparable boats at full speed. And at cruise throttle, both of our V-6s give surprisingly good fuel economy.

Though powered like tigers, our V-6s handle like pussy cats. Built-in power Trim'N'Tilt gives you finger-tip control of motor tilt for launching/beaching and of boat trim while running. And our accessory remote single-lever Command Center™ gives you one-hand control of power from start-up to all-out.

If you "run away" to sea often, consider our V-6 versions with 25-inch, extra-long shafts for higher stern freeboard. But whichever Sea-Horse® motor you choose, you'll get a true "salt water" outboard—all Johnsons are built to resist corrosion inside and out. See them at your Johnson dealer, or write for free catalog. Johnson Outboards, Division Outboard Marine Corporation, 3733 Sea-Horse Dr., Waukegan, IL 60085.

Under Outboard Motors

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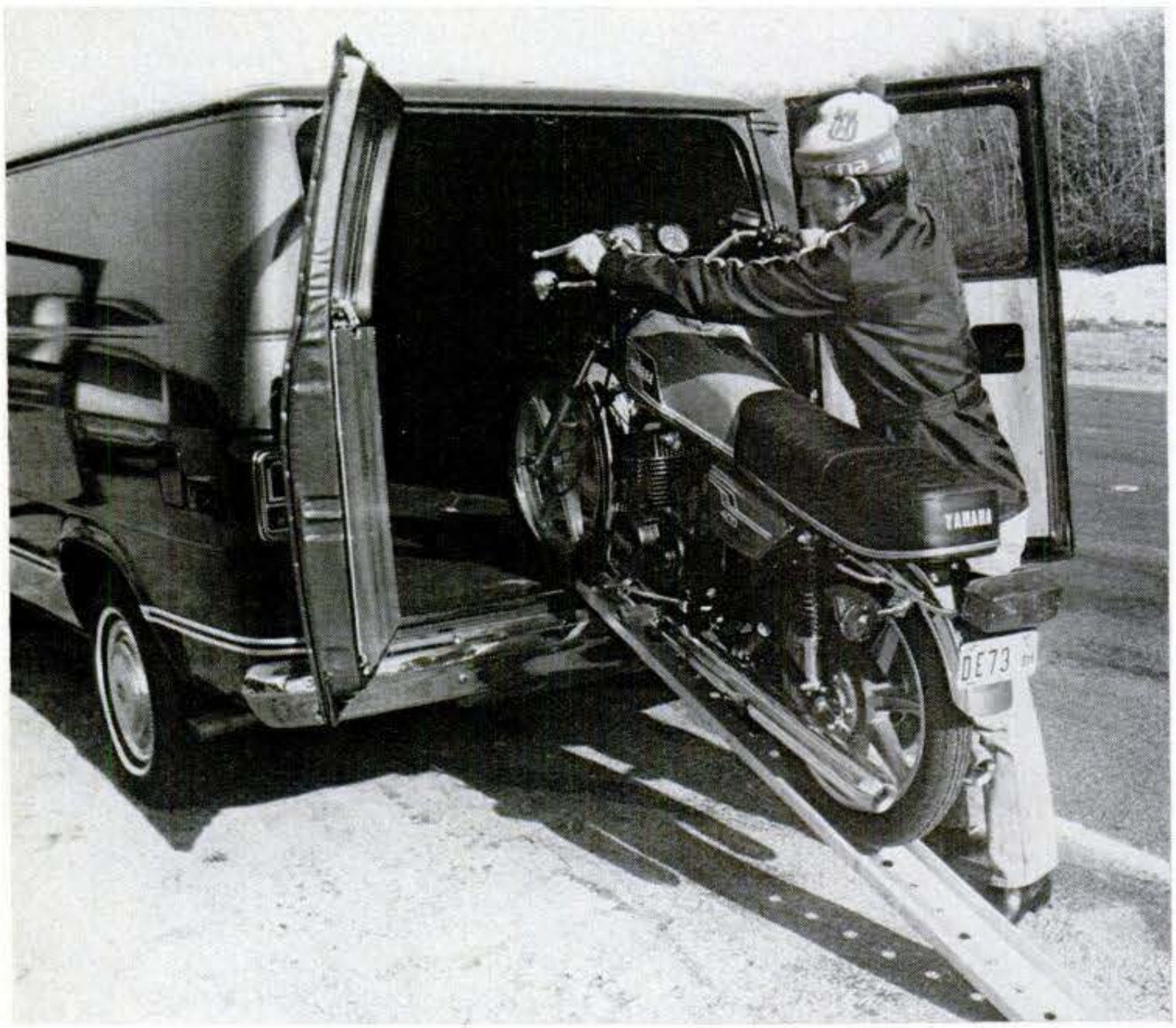

Carrying motorcycles, snowmobiles, or other recreational equipment is easy with a van. These vans have upwards of 250 cubic feet of open storage space.

Serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Ford	Chevy	Dodge
Checking fluid levels:			
Battery	5	5	5
Master cylinder	3	4	2
Windshield washer	5	5	5
Engine oil	2	5	3
Coolant	3	5	5
Checking engine:			
Spark plugs	2	2	2
Distributor	2	2	2
Carb adjustment	2	2	2
Oil fill	5	5	5
Oil filter	1	3	3
Replacing hoses:			
Top radiator hose	5	3	1
Lower radiator hose	3	2	2
Heater hoses	5	1	1
Changing light bulbs	5	5	5
Checking fuses	4	3	4
Spare-tire accessibility	5	5	5
Changing belts	2	2	1

versatility.

Besides that, vans are easy to drive, contrary to what some people think. Visibility in traffic is better than from a car, since you sit higher. And you quickly learn to adjust the side mirrors and use them smoothly when changing lanes, parking, and backing up.

Vans are actually more maneuverable in tight spots than a lot of cars. Ford's Cruising Van, for example, is only 186 inches long—a 1977 Ford LTD four-door sedan is 223.9 inches in overall length. And an LTD station wagon is 225.6 inches long. The longest van made, Dodge's big maxi-van, is only 212 inches long, shorter than a lot of full-size cars and station wagons.

Vans also come with many car-type features. The list of options is staggering. You can get a lot, some, or no windows, in the back. Seats in the rear, or no seats. Hinged side doors, a sliding side door, or no doors at all. Single back door or double back doors. Front seats that swivel, or seats that don't swivel. Interiors that are bare metal from the back of the driver-passenger seats, or interiors that are fully upholstered or paneled throughout. Engines from small sixes to big V8's.

You can customize the van yourself, or buy one that's altogether custom-finished, both inside and out. The Ford Cruising Van, for example, has a colored paint job on the outside that's an unlikely, but interesting, combination of silver, black, yellow, red, and purple. Its accessories include porthole windows, roof luggage rack, and an interior that is fully carpeted and insulated. Captain's chairs for two passengers have arm.rests, and swivel to face rearward.

Durability is another important factor. Vans are built to be sturdier than cars (they have to be; more is demanded of them). And they hold their resale value well, too.

Add these factors to the growing popularity of customizing vans (from minor interior decorating to full-scale conversions that turn a van into a mini motor home), and it's not hard to see why the van market is so healthy.

Our three test vans were the Ford E150 (because of a factory strike, we tested a '76 model), Chevy G20, and Dodge B200 (both '77 models). All have similar wheelbases (124-127 in.) and engine sizes (350-360 CI V8's). When we tested them at Bridgehampton, they did very well in some areas, poorly in others.

- *Fuel economy.* All three vans turned in a poor showing here. None topped 11 mpg in simulated city driving. In our simulated highway driving test, Chevy did best with 17 mpg. Ford got 15.6, and Dodge came in on the low end with 13.4. You could get better mileage with a small-displacement six-cylinder engine. But with the vehicle loaded to capacity, performance would probably be unsatisfactory.
- *Performance.* What these vehicles lack in economy they make up for in performance. The Dodge B200 set fastest times in all three acceleration tests—0-60, 0-80, and 20-70. All three vans are plenty peppy, though, and are as fast or faster than comparably powered V8 sedans. Part of this can be attributed to their relatively low curb weight—less than that of full-size cars.
- *Interior noise.* If you've driven an empty van with no insulation or paneling behind the driver-passenger area, you know it's like riding around inside a drum. The sheet-metal walls, floors, and ceiling vibrate loudly, and the noise of the driveline and tires comes up through the uninsulated floor. Our

Continued

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We are not patent attorneys, and if your invention is unpatented we encourage all inventors to consult one as to rights, searches, patentability, etc. If you do not know a patent attorney, write us and we will tell you how to obtain the names of all U.S. Patent Attorneys in your area and you can make your own choice.

To assist inventors we have prepared a booklet entitled "How To Offer Your Invention For Sale." This booklet contains such information as current royalty rates being paid by manufacturers, discusses various types of inventions and the markets for them, and tells the most effective methods you can use in presenting your invention, whether you employ us or do it yourself.

You can obtain a copy of this booklet merely by mailing the coupon below. It will be sent to you with our compliments, free, without any obligation whatever. If you wish to write us for comments about your invention, please do so. We make no charge for consultation. But please do NOT send blueprints or models.

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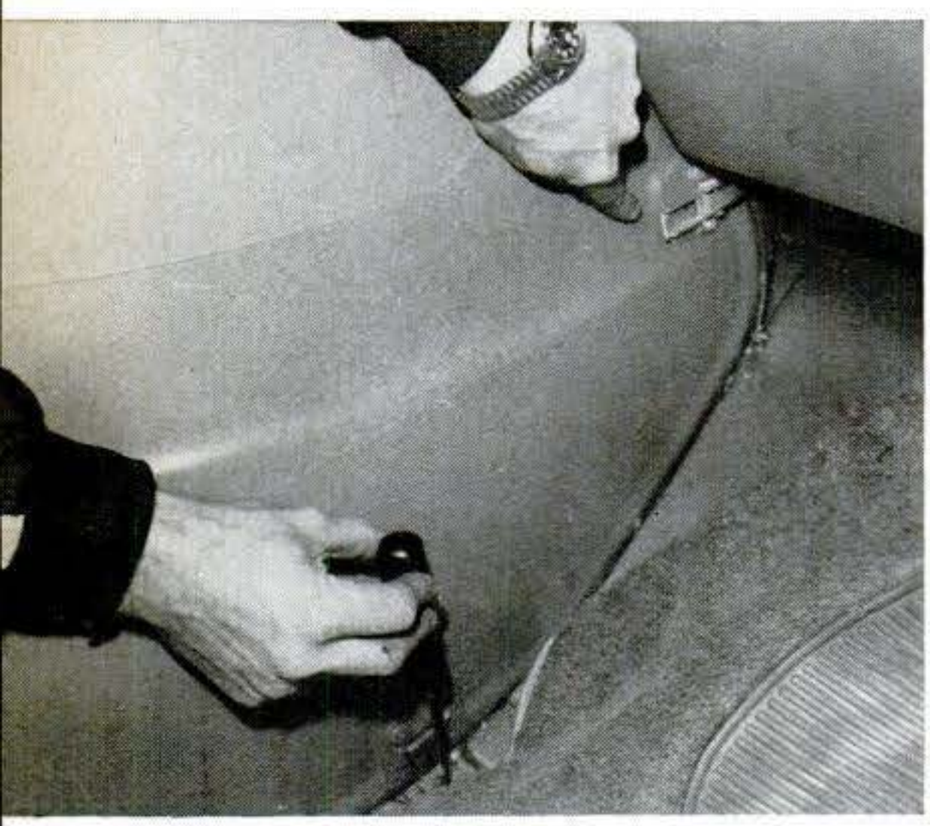
Ford Cruising Van is braking hard on PS braking grid. Fifth wheel provides accurate speedometer reading as vehicle enters the grid. Ford's panic braking performance was poorest of the three test vans.

Fuel mileage (mpg)

	Ford	Chevy	Dodge
Highway	15.6	17.7	13.4
City	10.0	10.4	10.5
EPA test (city)	13	14	13
(California, city)	11	13	*

Emission-control system: IMCO (Ford); Controlled combustion, no catalyst, no air injection (Chevy); heated intake air (Dodge).
*Not available with 360-cu.-in. engine.

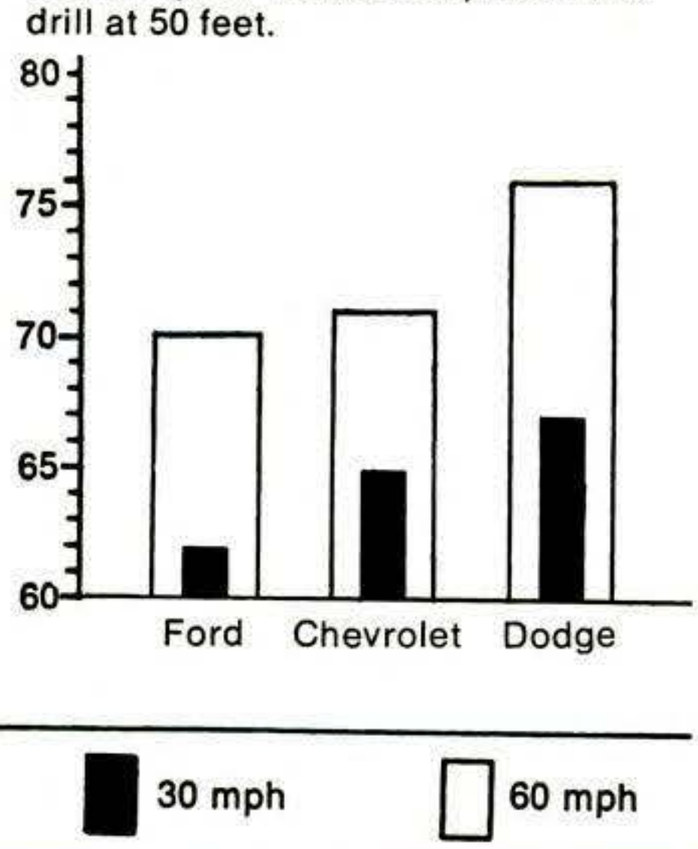


Removing engine cowl in any of the vans is a bit of a pain. You must loosen two clips and remove three screws.

Engine accessibility, even after cowl is removed, is still difficult—though it's better than in some cars.

NOISE-LEVEL TESTS

Interior noise is measured in decibels on the A scale on our standard General Radio sound-level meter applied under three sets of conditions. A reading of 50-dBA is like an average residence. A 60-dBA reading is like a large store; 70-dBA, like a freight train going by 100 feet away; 80-dBA, like a pneumatic drill at 50 feet.



test B200 Dodge was like this. Without insulation in the rear, it registered 76 dBA on a noise-level meter at 69 mph. That should not be taken to mean that all Dodge vans are this noisy. The Ford and Chevy would have given similar readings had they been without interior carpeting and trim.

With insulated wooden paneling on the walls and ceiling in the rear and an insulated rubber floor mat, however, the Chevy G20 registered a more tolerable 71. The Ford E150, with shag carpeting covering the entire interior (ceiling, walls, and floor), registered 63 dBA at 60 mph during a recent test. An inescapable conclusion of our tests: A van is noisier than a quiet sedan.

• *Braking.* When a large proportion of a vehicle's weight is on the front wheels, braking can be a problem. The front wheels provide the most traction, and do most of the stopping. The rear brakes tend to lock up the wheels because the rear tires ride lighter. Braking is complicated even further in a van, whose brakes must be calibrated for full-load and empty conditions.

We found no problem with the Chevy or Dodge brakes, but the Ford results were disappointing. In each of the two incipient lockup tests—one run with the brakes cold, the other with brakes hot—the Ford traveled the maximum distance over our 210-foot braking lane before coming to a stop. In addition, rear-wheel lockup caused driver-control problems.

One difference between a van and a sedan is ease of entry and exit. With a van you have to step up at least 17 inches to the floorboard and climb onto a seat 40 inches above the ground. Seat height of a typical sedan is 22 inches.

And the engine cowl gets in the way. Driver leg room in any of the three vans is as good or better than in most sedans, but the passenger gets shortchanged. It's poorest in the Dodge: Even with the passenger seat extended fully rearward, the occupant's left leg is crowded.

The Chevy is a bit better in this respect. Ford is best of all, with the smallest cowl intrusion in the passenger compartment.

Engine maintenance is more difficult than for a sedan. To get at the engine, you have to remove the cowl, by removing three screws and loosening two clips. Then the cowl must be lifted off and out—which is a lot more difficult than raising the hood on a car. Fortunately, you usually don't have to take the cowl off very often.

These vans represent a classic case of manufacturers responding to customer demands. Van popularity is at its peak right now, and buyers are demanding a variety of factory packages to fit their special needs. Detroit is delivering. PS

For specs and test results, turn page

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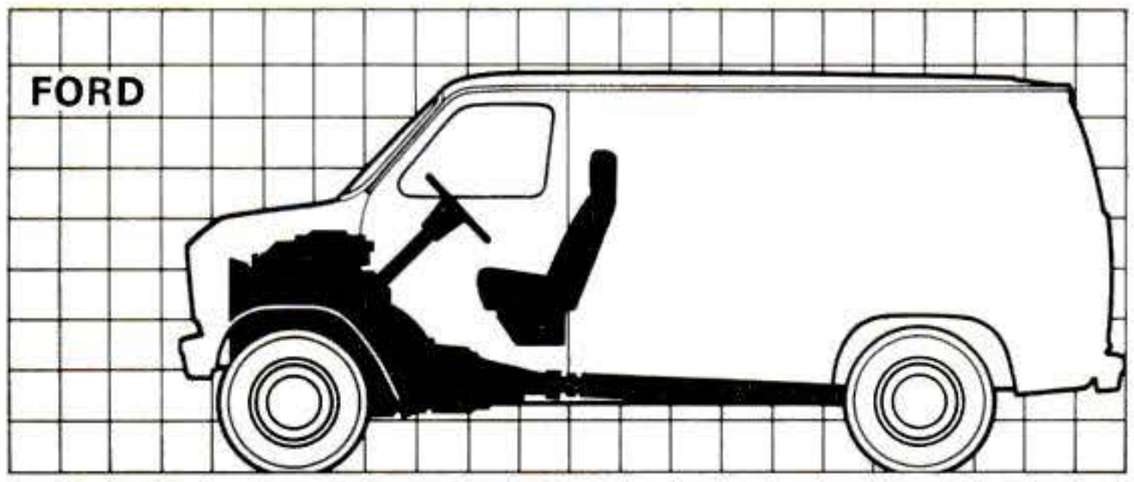

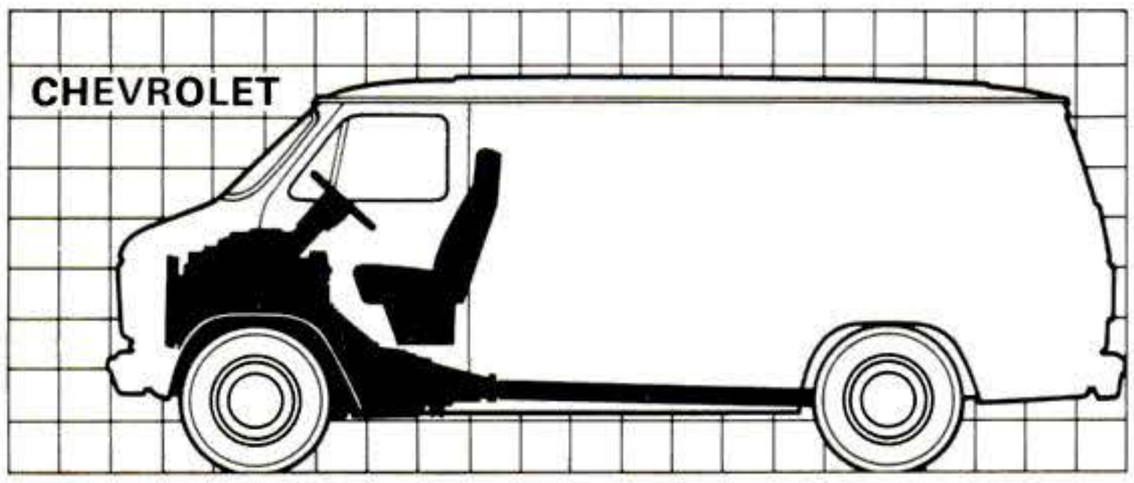

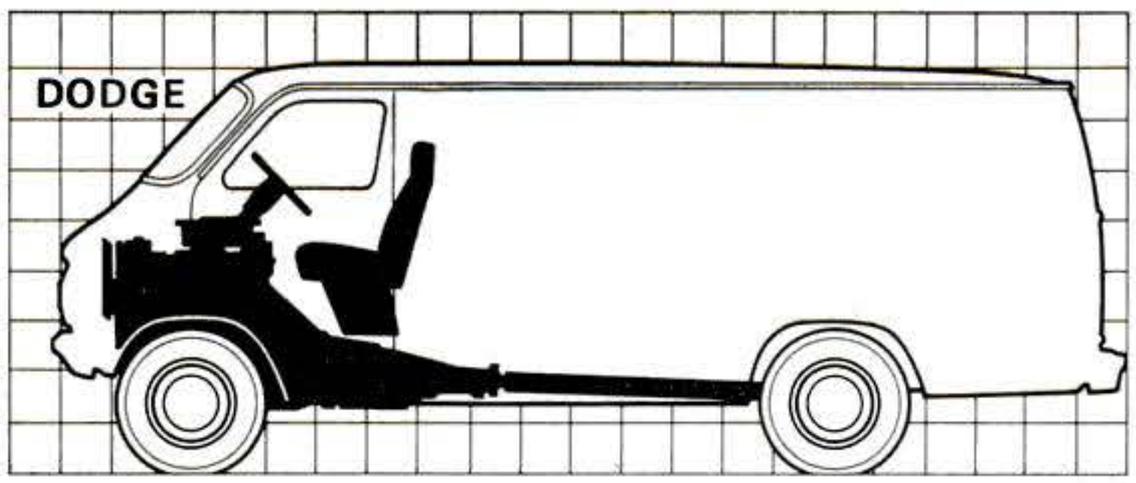

Space is a van's greatest asset, as the chart shows. Even if a seat or two is added behind the driver-passenger seats, you've still got a lot of storage area. Accessories, such as A/C, AM/FM radio, and speed control, are readily available. On some Chevy vans you can even get a tilt wheel.

Performance comparison with selected 1977 and 1975 models

	Mpg (city driving)	Accel. 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuver (mph)	Noise @ 60 mph (dBA)
1975 Chevrolet Sportvan 350 V8	12.2	15.1	142	47.2	23.6	72
1975 Dodge Royal Sportsman, 360 V8	11.3	14.9	150	49.9	25.0	73
1975 Ford Chateau Club Wagon 460 V8	11.2	14.5	194	49.9	22.4	72
1977 Ford Thunderbird V8	12.7	15.1	163	54.5	25.0	67
1977 Olds Cutlass V8	15.2	12.3	180	60.0	25.0	65
1977 Chevrolet V8	15.0	13.5	142	60.0	28.6	63
1977 Ford LTD V8	11.0	13.9	168	51.3	22.4	64
1977 Plymouth Gran Fury V8	12.0	15.2	143	49.9	24.6	65
1975 Astre Wagon V4	18.6	19.7	157	56.3	26.4	72
1975 Bobcat Wagon V6	15.5	17.2	123	58.2	26.0	69

Ford, Chevrolet, and Dodge— specs, dimensions, and test results

	FORD E150 Chateau Cruising Van	CHEVROLET G20 Caravan	DODGE B200 Street Van
DIMENSIONS (inches)			
Ground clearance	6.8	6.9	7.75
Front leg room (max.)	44.7	42.5	42.5
Front head room	38.2	37.5	38.0
Front hip room	22.0	22.0	22.0
Wheelbase	124.0	125.0	127.0
Overall height	79.2	78.5	80.8
Overall width	79.8	79.9	79.8
Overall length	186.8	201.0	212.0
Front track	69.4	68.6	65.7
Rear track	66.4	66.9	64.0
SPECIFICATIONS			
Engine type	OHV-V8	OHV-V8	OHV-V8
Displacement (cu. in./cc)	351/5736	350/5752	360/5900
Compression ratio	8.3:1	8.5:1	8.2:1
Carburetion	2 bbl.	4 bbl.	4 bbl.
Net hp @ rpm	147 @ 3400	127 @ 3800	165 @ 4000
Net torque @ rpm	276 @ 1800	270 @ 2400	290 @ 4000
Transmission	3-speed automatic	3-speed automatic	3-speed automatic
Axle ratio	2.75:1	2.76:1	3.21:1
Tire make	Firestone	General	Goodyear
Tire type	Deluxe Champion Belted	Dual Steel Radial	Polyglass Custom Wide Tread
Tire size	HR78x15	JR78x15	H70x15
Steering	Power Recirculating ball	Power Recirculating ball	Power Recirculating ball
Overall steering ratio	17.5:1	29.4:1	24:1
Turns, lock to lock	3.9	4.25	3.5
Turn diameter (ft.)	42.4	48.7	46.2
Front suspension	Twin I beam w/ coil springs	Independent coil springs mounted on lower control arm	Independent coil springs mounted on lower control arm
Rear suspension	Solid drive axle w/semi-elliptical springs	Solid rear axle with 2-stage multileaf springs	Full floating solid axle w/leaf-type springs
Front stabilizer-bar diameter (in.)	None	1.06	None
Rear stabilizer-bar diameter (in.)	None	None	None
Loading-area average (in.)			
Length	103.0	120.0	112.0
Width	66.5	70.2	70.0
Between wheel wells	48.0	52.5	50.0
Height	52.0	53.0	51.0
Brakes	Power	Power	Power
Brake type	Disk/drum	Disk/drum	Disk/drum
Brake swept area (sq. in.)	444.8	432.3	384.9
Fuel tank (gal.)	18	21 (+12 optional)	22
Liftover height (in.)	27.0	25.3	27.2
Curb weight (lb.)	3784	3765	3645
F/R weight distribution (%)	58/42	57/43	57/43
Trailer-towing capacity (lb.)*			
Tongue weight	6000-10,000	6000	7000
Gross weight	600-1500	600	750
Basic price	$4327	$5282	$4629
Price as tested	$7074	$7952	$6876
TEST RESULTS			
Acceleration 0-60 mph (sec.)	14.9	14.2	12.1
Acceleration 0-80 mph (sec.)	28.4	27.3	22.5
Acceleration 25-70 mph (sec.)	16.5	15.8	12.4
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	210	152	150
Pedal pressure (lb.)	65	155	90
Efficiency (% of 1 g)	100	98	98
Disk temperature (°F)	196	120	175
Brake test (hot) (60-0 mph)			
Stopping distance (ft.)	212	156	147
Pedal pressure (lb.)	90	140	135
Efficiency (% of 1 g)	91	100	100
Disk temperature (°F)	485	565	390
Handling test (mph)	54.5	54.5	56.3
Maneuverability (mph)	25.3	24.25	25.0
Interior noise @ 60 mph (dBA)	70	71	76

TEST CONDITIONS: Ambient temperature 43°F; relative humidity 75 percent; barometric pressure 30 inches

*Maximum load with appropriate engine and tow bar

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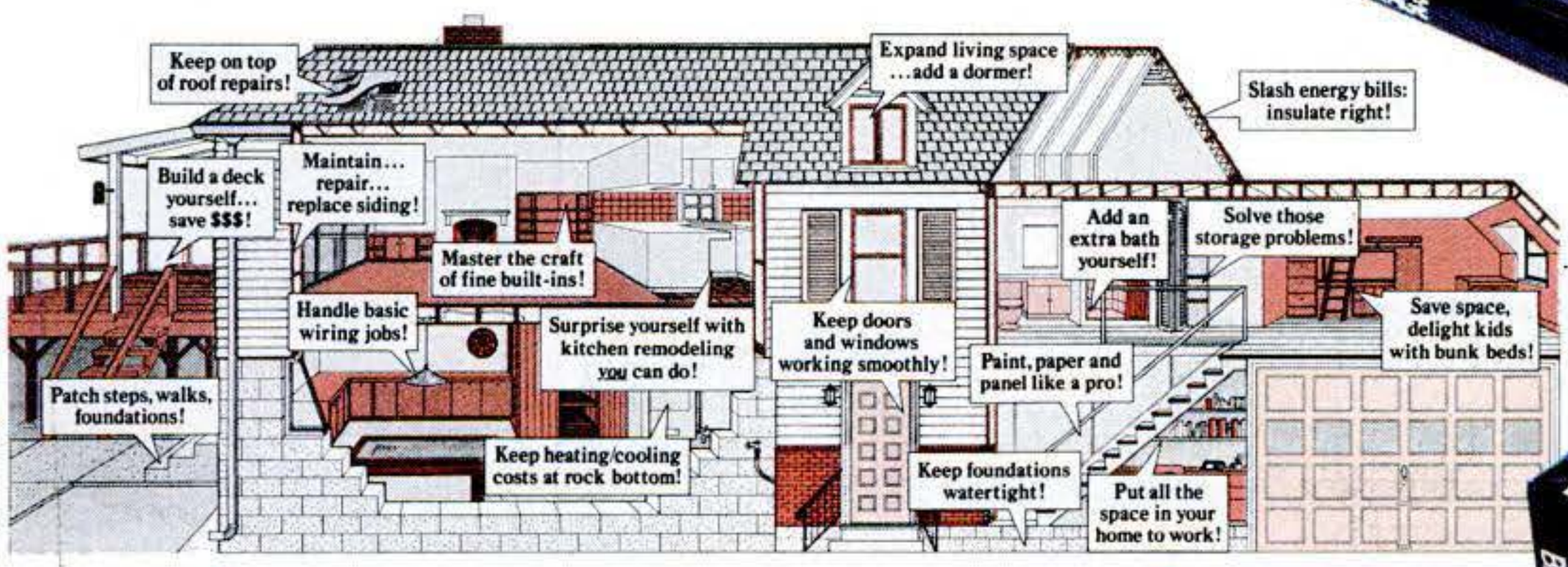

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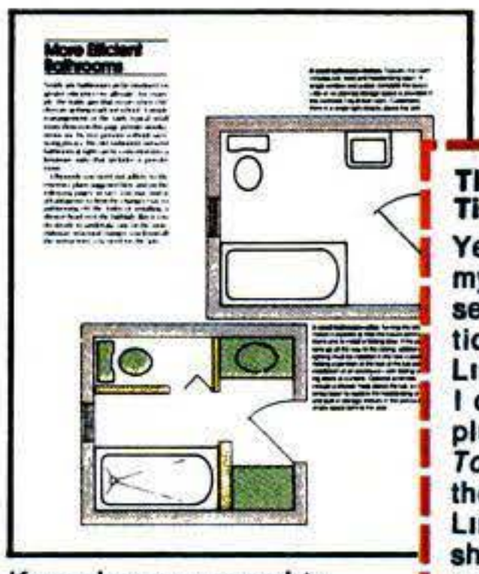

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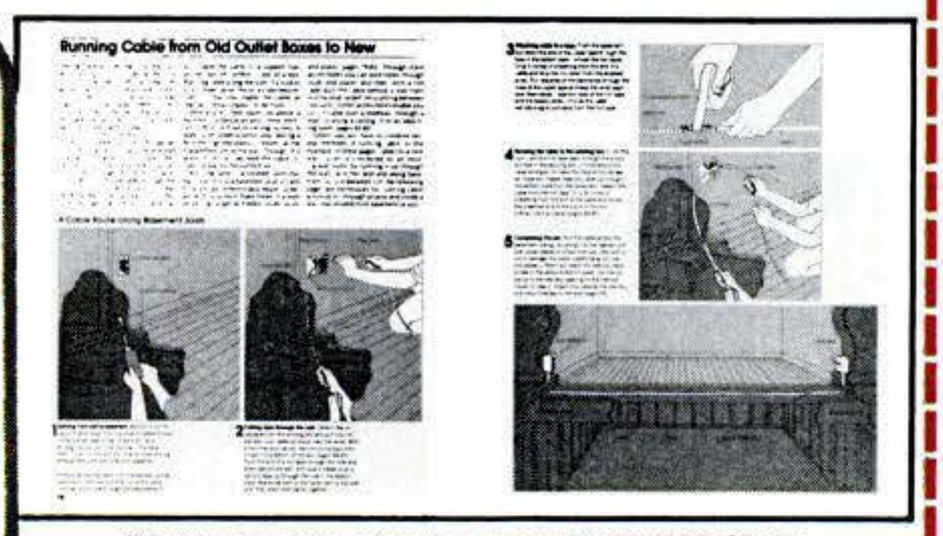

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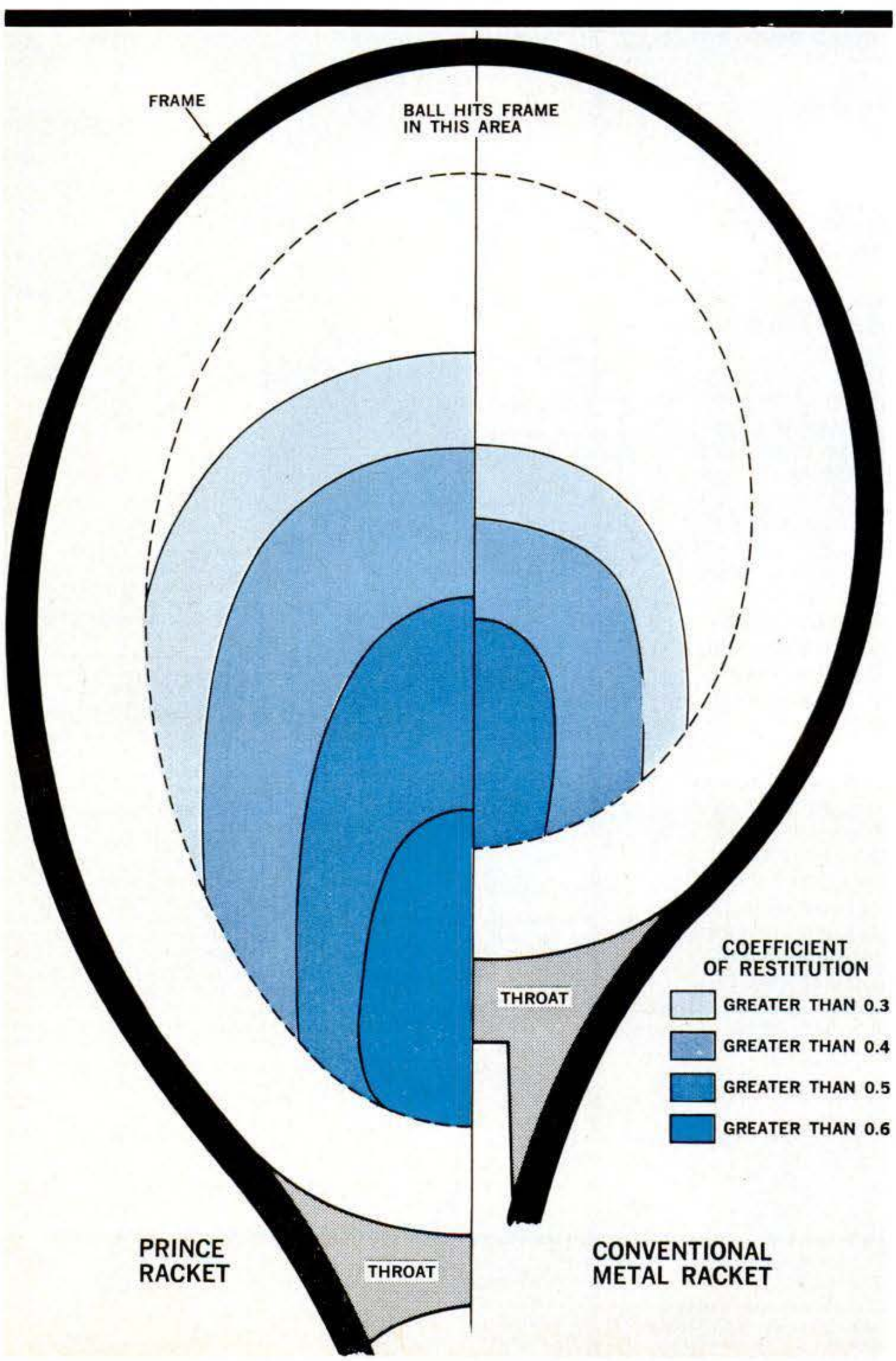
Super racket

-is this the shape of things to come in tennis?

Side-by-side comparison of Prince racket with conventional model shows prime difference is in head size; each has same length, weight, balance.



One measure of racket's power is coefficient of restitution (c.o.r.): ratio of struck ball's speed to incoming speed. The higher the c.o.r., the better. Diagram records lab tests of Prince racket (left half) vs. typical metal racket. Tinted areas combined make up the "sweet spot," where ball should be hit for best response. Based on these data, Prince racket has larger sweet spot, achieves higher c.o.r.'s than previously achievable.

By ARTHUR FISHER

"But is it legal?"

That's what they ask me when I step onto a tennis court brandishing the new Prince racket. It's not a surprising reaction. For the last 75 years or so, tennis players have been used to seeing rackets of roughly the same size and shape. The first really radical change in that geometry is the Prince—an outlandish object resembling a deranged snowshoe. The surface area of its head is a full 50-percent larger than that of a conventional design. Reason: to let you return more balls and hit them better.

Is that legal? Absolutely. The rules of the game specify all sorts of things about the court, the net, and the ball, but state only that a player must strike the ball with an "implement." You are entitled, if the fancy takes you, to whack a tennis ball with a pool cue, butterfly net, or the door off an old pickup.

Even though the Prince racket looks outrageously different, its heft is hard to distinguish from that of a normal racket. That's because its length is the same—27 inches—and so is its weight and balance.

Continued

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According to a U.S. Government publication:

The New Chevrolet has 5 more cubic feet of room inside than our nearest sales competitor's older style full-size cars.

The Caprice Classic Sedan

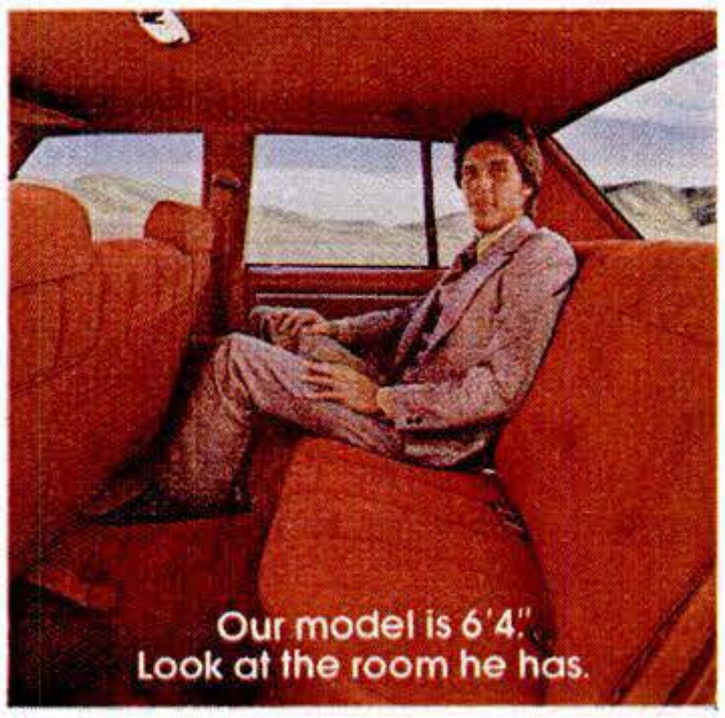
Five cubic feet.

That's how much more passenger room there is inside The New Chevrolet than there is inside this year's older-style full-size cars of Chevy's nearest sales competitor.

Five cubic feet.

And you don't have to take our word for it.

That's based on U.S. Government estimates of vehicle interior size, as reported in the 1977 EPA Guide for New Car Buyers. You can get a copy at any new car showroom.



Five cubic feet.

It's not Grand Canyon, but it's a sizeable difference. Enough, we hope, to cause you to wonder why anybody would need that extra "size" on the outside of the car when you can get so much room and comfort inside the crisp, contemporary, trend-setting 1977 Chevrolet.

Sit in a New Chevrolet soon and see.

Chevrolet

Now that's more like it.

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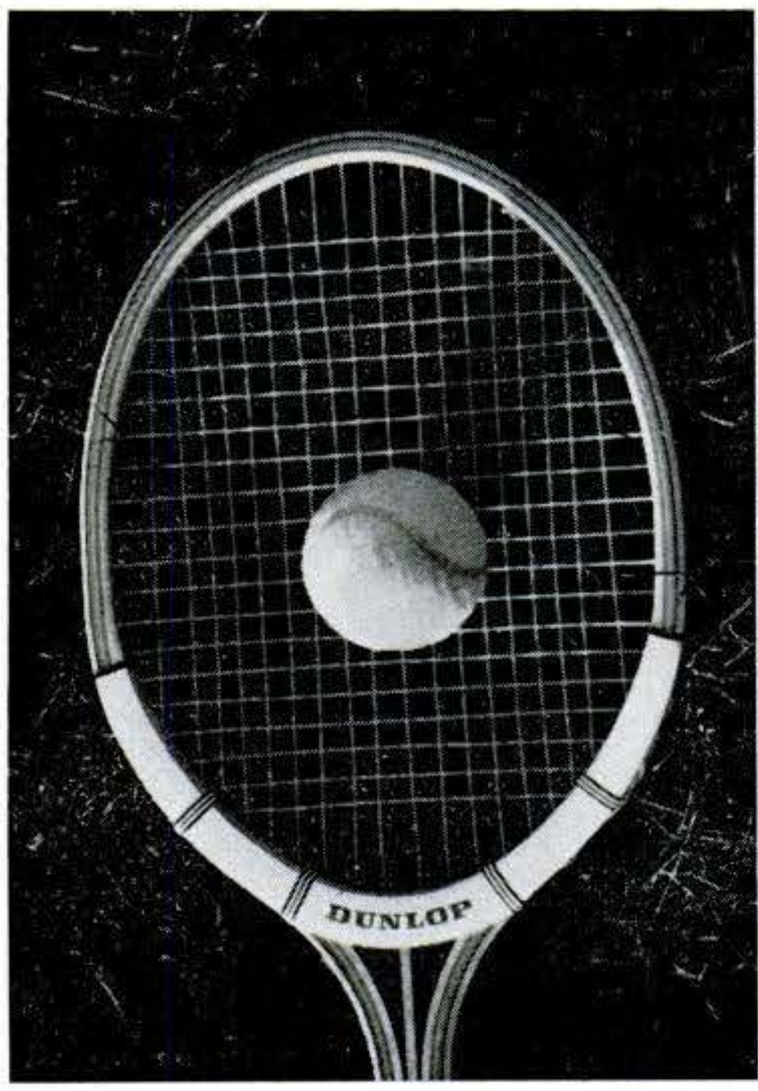

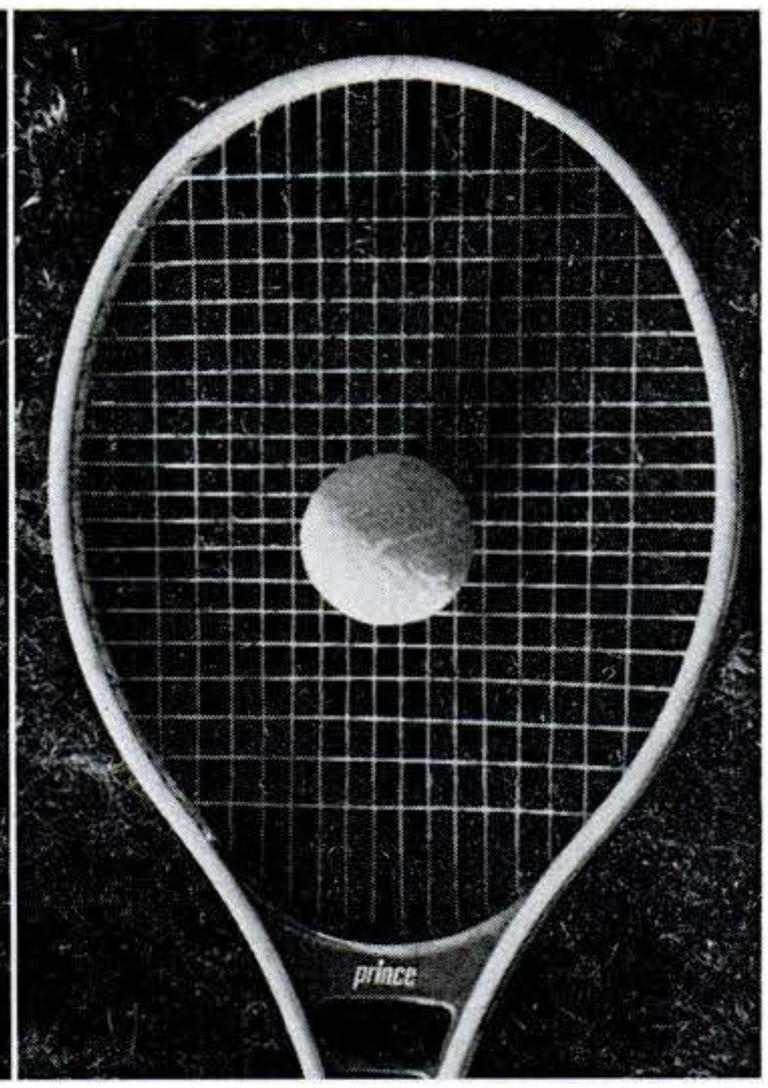

Stringing pattern of Prince racket (right) differs from standard design, shown on typical wood racket (photos are to same scale). Instead of uniform spacing, Prince strings are closer together near center of head, farther apart as they near frame. Result is fewer strings. Although Prince's strung area is 50 percent larger, it needs only 10 percent more string. Nylon is recommended, at tensions 12 to 15 pounds higher than normal because strings are longer.

When the Prince's inventor, Howard Head, first showed me the racket, he brought along another aluminum racket of conventional design. "Close your eyes," he commanded, "and swing each one without actually hitting a ball. Can you tell the difference?" I couldn't. Even the wind resistance seemed the same.

Howard Head, of course, is the entrepreneur-inventor who overturned the ski business by fabricating the first successful metal skis, after skiers had schussed along on wood for centuries. Head skis became very successful indeed, and in 1969 he sold his lion's share of the Head Ski Company and retired with a tidy number of millions.

Today Head is chairman of the board of the Prince Manufacturing Co. of Princeton, N.J., a longtime maker of the ball machines used in tennis schools, and now the happy producer of the Prince racket. (There is a line of high-quality rackets bearing the name Head and made by AMF, the purchaser of the old Head Ski Company, but Howard Head was only marginally involved in developing one of them, the Arthur Ashe model.) The principal advantage Head claims for his new Prince racket: a "sweet spot" some four times larger than a conventional racket's. The sweet spot is the best place on the strings to hit the ball in order to assure a clean, hard return.

"The funny thing," Head told me, "is that I didn't set out to design an oversize racket at all. After I'd retired, I decided to learn to play tennis. But I had a hard time, especially because the racket twisted off center every time I hit the ball, spoiling the shot. It spun out of my hand when I returned a hard serve off-center. I was as unhappy then with state-of-the-art tennis rackets as I had been in 1947 with wood skis."

In 1972, drawing on his structural-design know-how, Head began thinking of ways to reduce the annoying torque. One way would be to increase what physicists call the polar moment of inertia about the racket's long axis. That quantity increases with the mass distributed around the head, and also with the square of the head's radius. At first, Head tried increasing the head edge mass of a regular wood racket by adding weights to it. "Not only didn't that succeed in reducing the torque," Head recalls, "but when I played with the racket it broke."

Then, Head says, "I woke up in the middle of one night and realized that I should move the mass away from the center, by making the head wider." At 10½ inches wide, in contrast to the conventional 8½, the Prince racket gains a 50-percent advantage in polar moment of inertia, says Head. This contributes, in part, to the larger sweet spot.

But there was another, unexpected dividend. The enlarged head shape—made possible by the use of extruded aluminum alloy instead of wood ("wood would have collapsed or been too heavy")—brought the strung area down some three inches closer than normal to the handle of the racket. The result, Head says, was to move the *center of percussion* to within the playing area. This is the point where the energy of something swung—a bat, say—is most efficiently transferred to another object. For something whose mass is uniformly distributed along its length—like a tennis racket—it is about two-thirds the way between the point of rotation (your hand) and the top of the racket. (If you're a baseball player and you hit a ball near the tip of the bat, your hands sting and the ball goes dead. Hit it farther down at the center of percussion and the ball goes over the fence.)

"This means," explained Head, "that there is no perfect place to hit the ball on a conventional racket. The center of percussion is too near the racket throat to be easily hit. The Prince's sweet spot is 2½ times longer than normal because the center of percussion lies almost perfectly within it."

[*Continued on page 150*]

Valerie Ziegenfuss beat English champ Virginia Wade with a Prince racket.

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Electric bike

pancake motor runs 40 miles on a charge

A snappy motor in the front fork delivers high-torque performance up to 18 mph

By DAVID SCOTT

MELBOURN, ENGLAND

As I eased open the twist-grip throttle on this electric bicycle, the motor centered in the front wheel did a gentle chug-a-lug, and we inched smoothly ahead. Twisting the grip further, I soon saw the electronic speedometer steady at 15 mph. A gentle hum was the only sound. I swept up a 12-percent grade and the speed dropped slightly, to 11 mph. At the top I closed the throttle and glided to a halt without touching the brakes.

Still a prototype, this extraordinary bike has a unique high-efficiency pancake motor and all-electronic controls that also charge the battery when coasting. It runs for up to 40 miles on two small lead-acid car batteries. The motor was designed in the laboratories of Patscentre International at Melbourn, near Cambridge, in cooperation with Sedgeminster Technical Developments of London. Sedgeminster is discussing licensing deals with a number of likely manufacturers in 16 countries.

First taker: Mohatta Brothers of Bombay, India, a concern that already manufactures 1.5-million push-bikes annually. They plan to begin exporting both complete bikes and motor kits for retrofits in October, 1977. Expected retail price for the front-wheel kit (including batteries) is about $115. Marketing is to be worldwide.

Front-drive electric bicycle has synchronous motor and gearbox integrated in front hub. Top speed is 18 mph in prototype form; range is up to 40 miles with two small auto batteries. Positions of motor and batteries keep center of gravity low. Control box could be reduced to 6-by-4-by-3 inches.

The bike's motor is only 3.3 inches thick. It is rated at 350 watts or one-half horsepower, and weighs 15 pounds.

"We call it a self-commutating multiple-pole synchronous motor," Dr. David Turner, one of the Patscentre scientists, told me. That mouthful means that it's self-starting without brushes, and can deliver high torque at low speeds.

A conventional electric motor has a rotating armature with several wire coils looped around the ends of iron cores, away from the magnetic field where they do no work. This motor has a simple circular winding packed inside a hollow ring formed by blocks of U-shaped laminations (see drawing). Losses are thus cut, and much more of the input power is put to work. Efficiency is nearly doubled—to around 85 percent.

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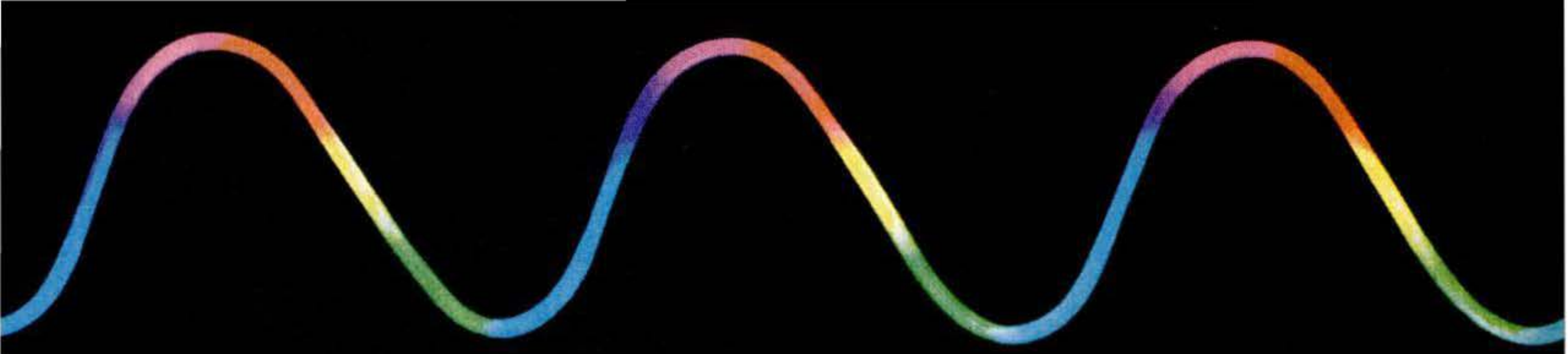
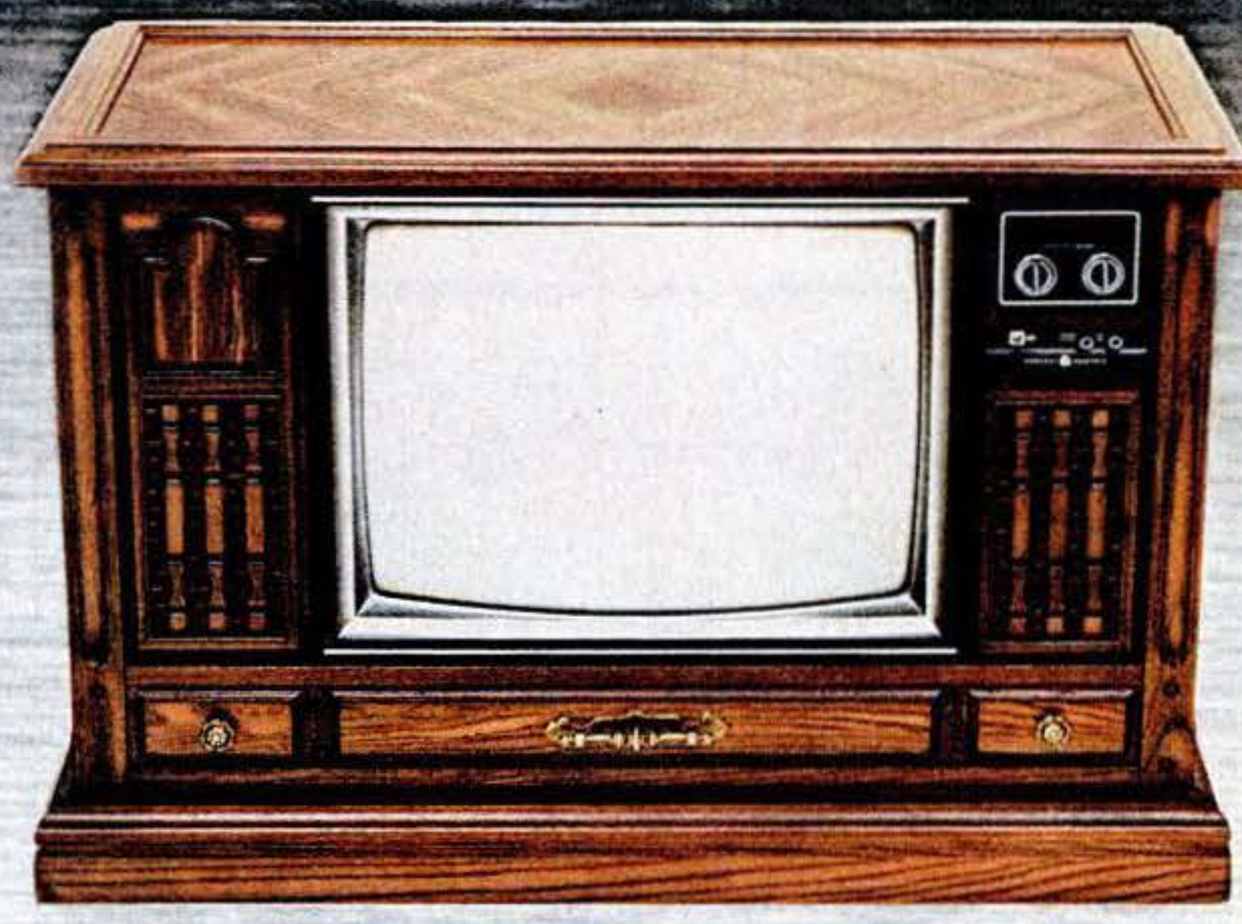


There's a signal in the air that lets the broadcaster control the color.

There's a set that can use it now.

Ours.



Cabinet constructed of hardwood solids, veneers and simulated wood accents.

Our set is General Electric. The signal is called V.I.R. And both are remarkable. Many TV programs are now transmitted with this special V.I.R. signal. Advanced computer-like circuitry, in selected GE color models, uses this V.I.R. signal to give you color and tint adjusted by the broadcasters themselves. 60 times every second. Continuously. Automatically. This means you won't have to fiddle with color control settings, because General Electric's V.I.R. system makes these adjustments for you. All you have to do is sit back and enjoy broadcast controlled color.

We invite you to see a demonstration at your GE dealer. Look for the V.I.R. light on a General Electric set. It tells you the V.I.R. signal is being sent and being received by the GE set. Then watch the GE set automatically adjust the color in the picture. You've got to see it to believe it.

V.I.R. Broadcast Controlled Color. GE has it. Now.

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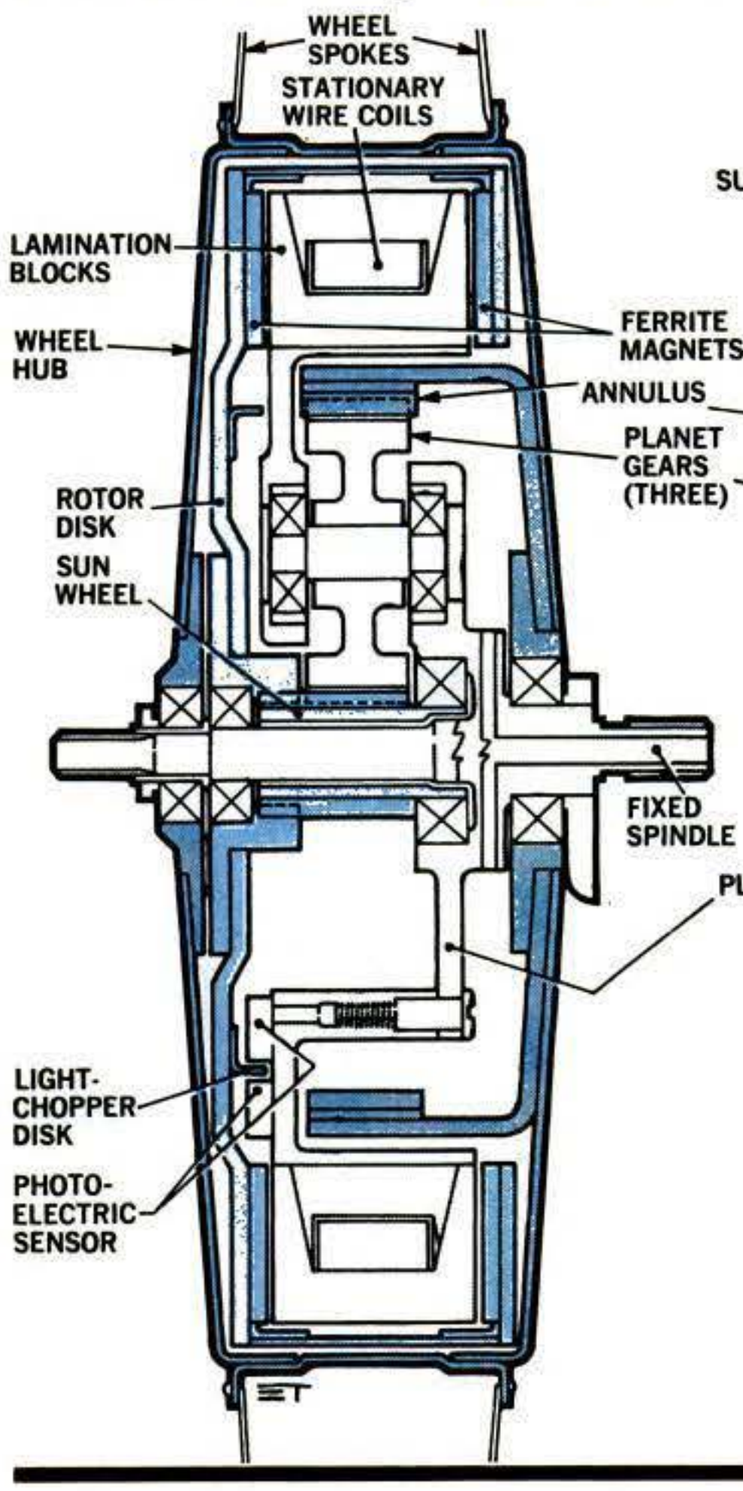
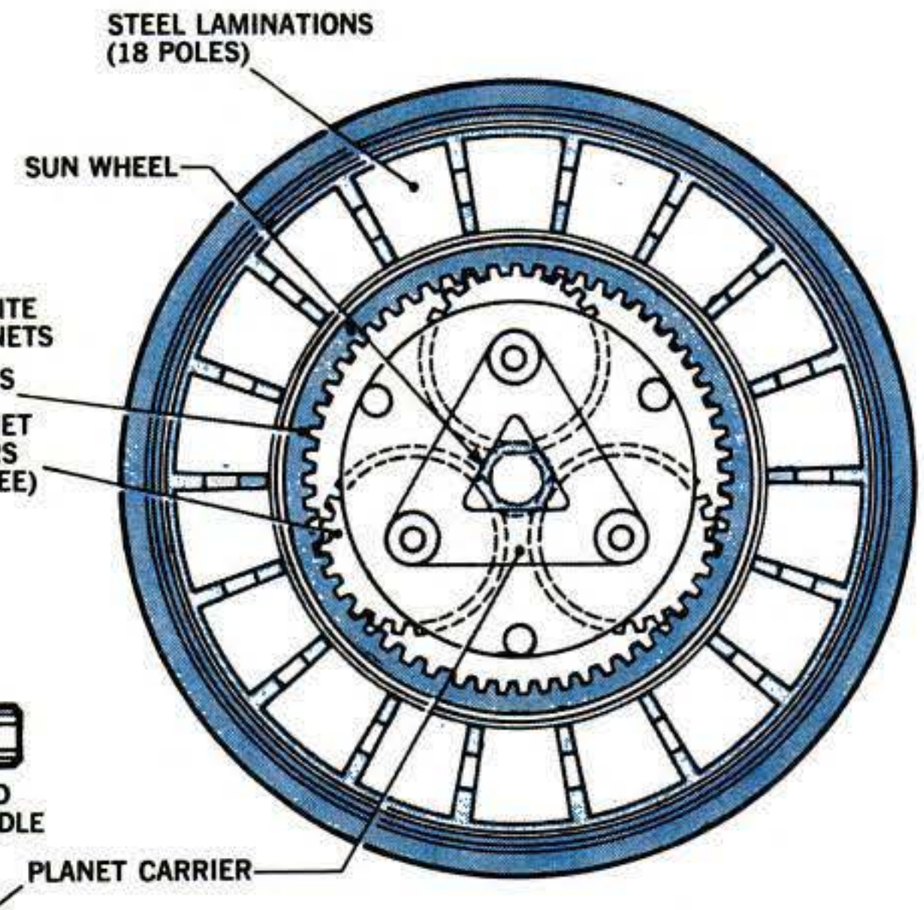
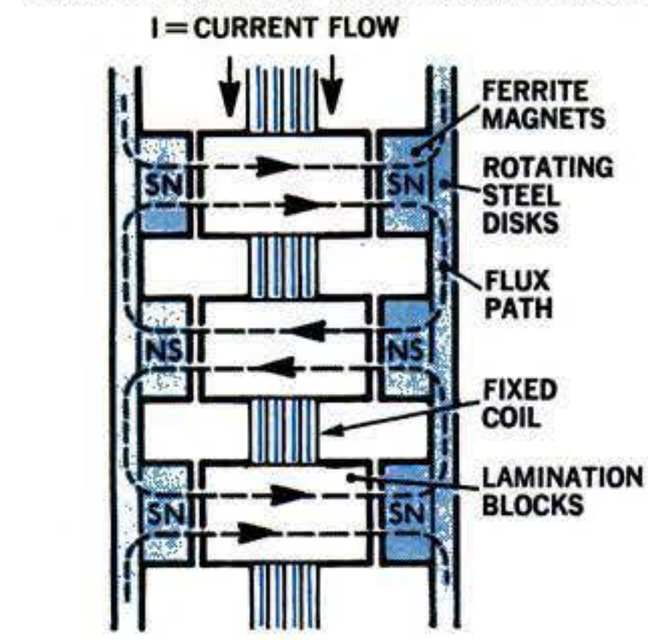
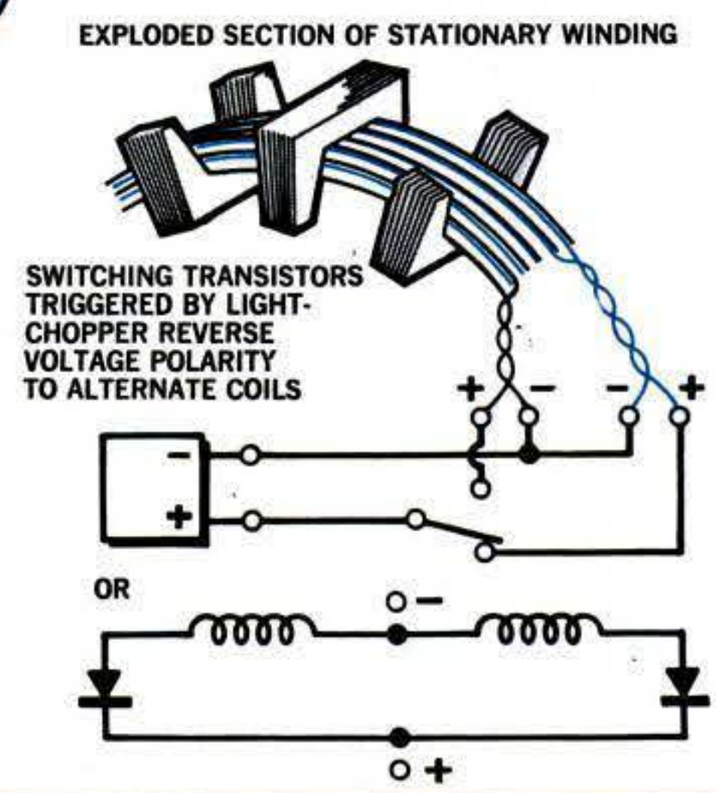
How the bike's pancake motor works





Stationary electromagnetic coil on fixed hub spindle is sandwiched between two rotor disks faced with thin permanent magnets. The disks enclose the drum-like assembly, which has an epicyclic gear train centered inside the coil. These gears provide a 5.2:1 reduction, and drive the 8.6-inch-diameter hub ring. Details at right show current flow and how voltage polarity is reversed to alternate coils.





The torque at low revs, and easy starting from rest, are made possible by the pancake design's 18 magnetic poles rather than the usual two; power impulses are closely spaced. Each block of laminations in the ring is an individual pole. These are faced on both sides by an equal number of strontium ferrite plate-type magnets cemented around the two steel disks with N and S poles alternating.

Costs cut

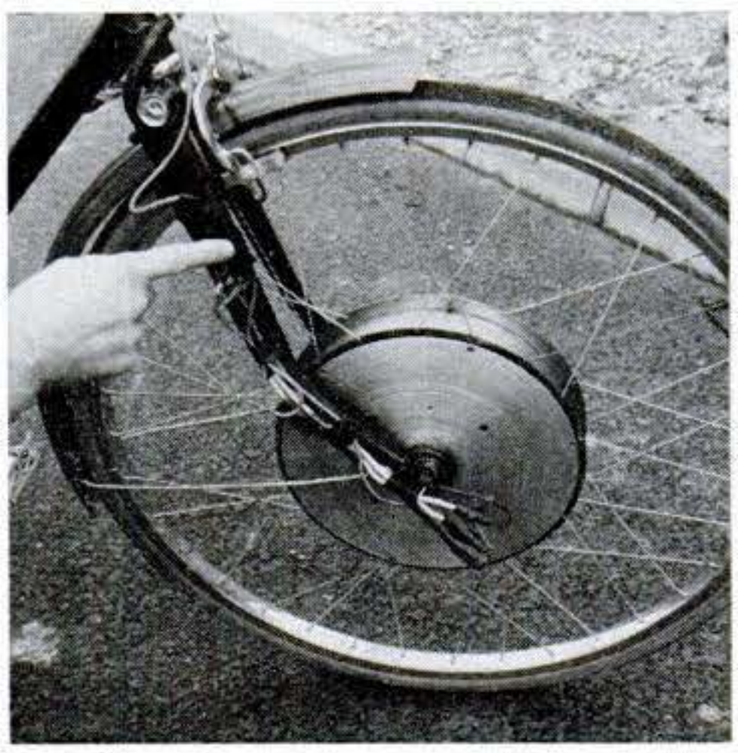
Since this is a DC motor, there must be a current reversal through the winding every 1/18 turn, or 20 degrees, to keep the rotor moving. "This could be done with four switching transistors to reverse the voltage polarity," Turner explained, "but we wanted to reduce the number of electronic components to cut the cost. We do the same thing more cheaply with two transistors, and have two separate concentric coils wound together."

These transistors simply flip the battery supply from one coil to the other like a single-pole, double-throw switch, changing the direction of current flow and therefore the electromagnetic flux each time. Switching is done by an electronic commutator.

A light-emitting diode (LED) shines on a phototransistor through a rotating disk perforated with 18 holes. The disk interrupts the beam, and the circuit is arranged so that alternate switching transistors are triggered after each blackout.

All external electronics is in a control box carried on a luggage rack. It includes a circuit for regenerative charging and braking, which does the job without any mechanical contactors. When you're coasting, this circuit automatically converts the motor into a generator: When the throttle is closed and twisted forward, it feeds power back to the batteries.

At low speeds this feature works as an electromagnetic retarder to slow the bike gradually to a stop. The normal friction brakes are usually needed only for sudden stops. The control box also houses a battery charger for overnight recharging. PS



Motor fits front fork of standard bike, making retrofit of existing bicycles an attractive possibility. Wires from electronic commutator and motor winding connect to batteries and control box at the terminal block, which is taped to fork (see pointing finger) on the prototype.

Twist-grip control turns a potentiometer in a photoelectronic control circuit that regulates speed by pulse variations. Motor current is indicated on ammeter; drain is 40 amp at stall, dropping to 15 amp at 15 mph on a level road. Electronic speedometer is in center of handlebar.

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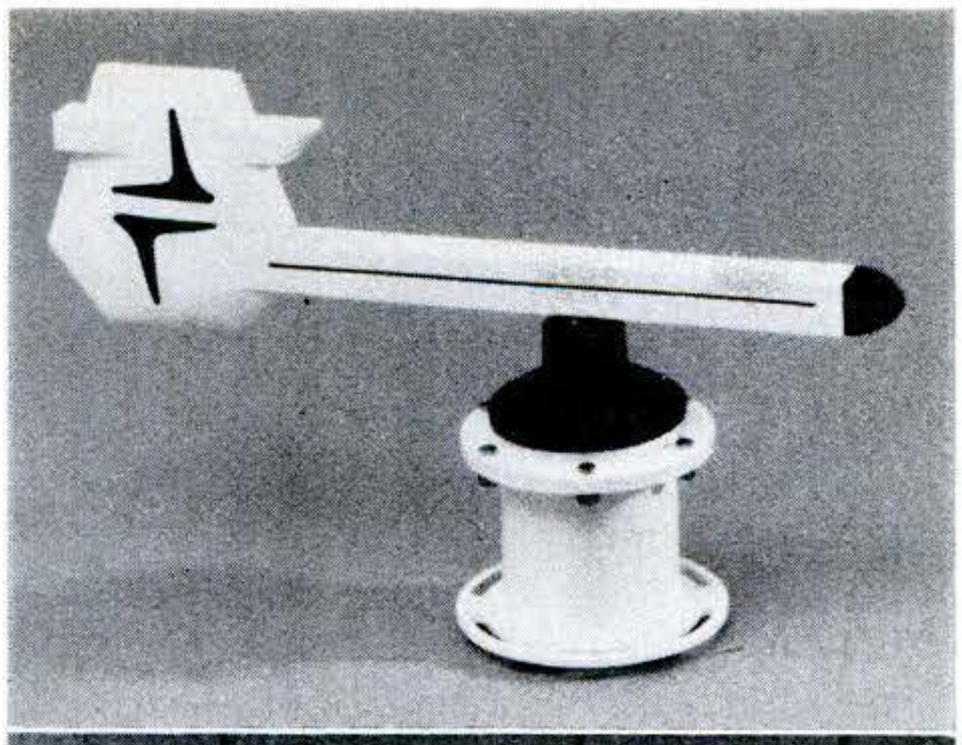
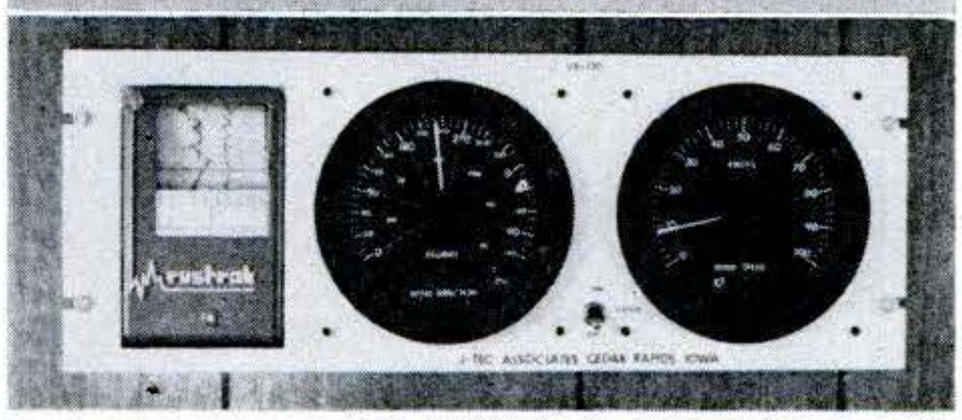
Vortex sensor measures wind speed with no moving parts





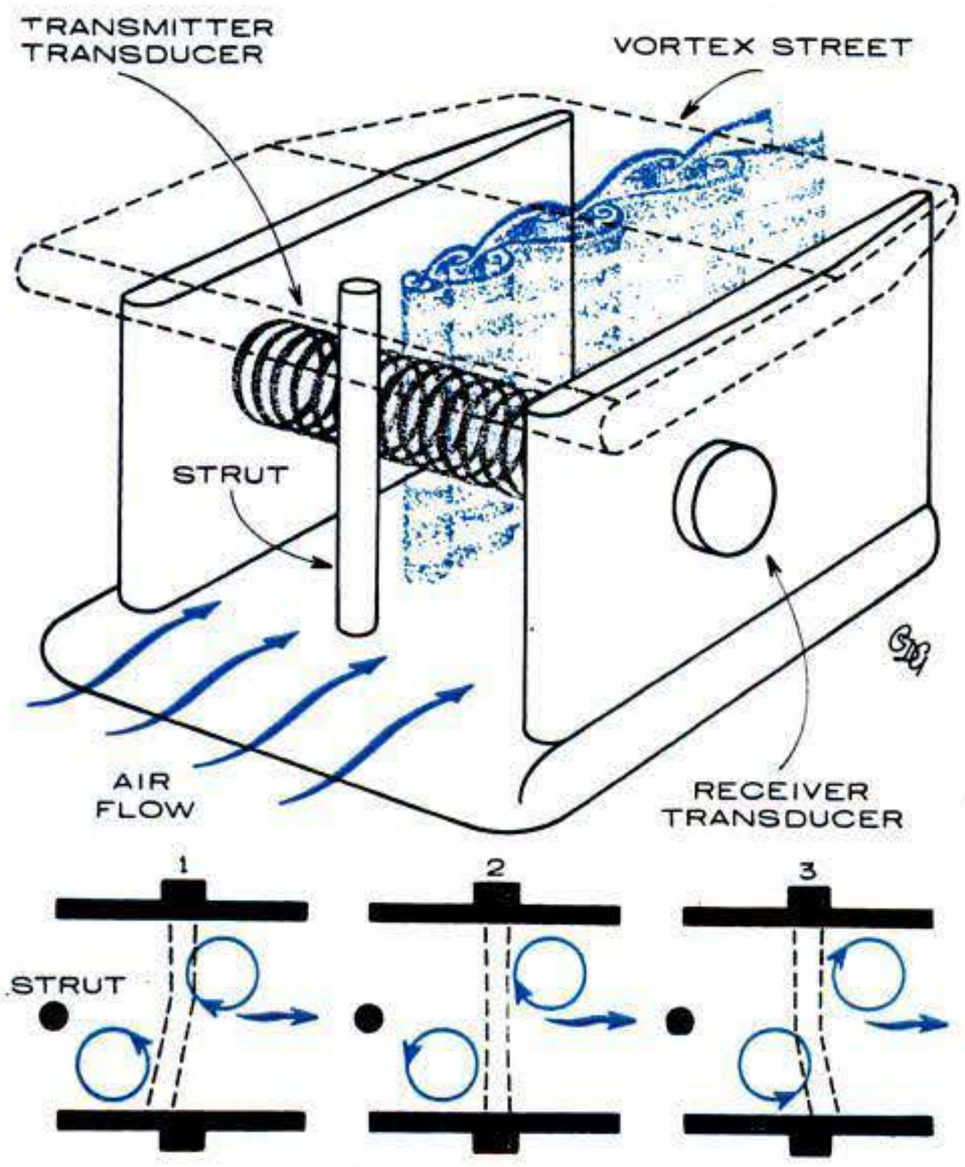
Tail of J-Tec anemometer vane houses ultrasonic transducers (below) that sense wind velocity. A variable resistor in the cylinder registers wind direction. Various meters and recorders serve as readouts.

A flag waving on a pole, the swirls in your coffee cup, and a new microcircuit-packed anemometer from J-Tec Associates all have something in common: They demonstrate a phenomenon called Karman vortex shedding. Put an obstruction or strut in the path of flowing fluid, and a series of vortices or whirlpools snake out behind the strut. Researchers, including von Karman early in this century, realized that counting the number of vortices formed each second enables you to calculate a fluid's speed.

But until recently, vortex counting has been impractical. A variety of heat-, strain-, and pressure-sensing probes can do the job, but each has problems that limit accurate, prolonged use. In 1969, a nonmechanical technique was developed to detect vortices with an ultrasonic beam. J-Tec has used this method to create gas and liquid vortex meters for many applications.

Now the Iowa firm has miniaturized its larger scientific anemometers and introduced a 2.8-pound instrument, the VA-320, which is about 10 inches high and 17 inches long. Custom and standard integrated circuits, located on a circular board attached to the vane shaft, helped make the scaled-down anemometer possible. (The anemometer sensor is $495; a display meter costs $125 to $500.)

The unique ultrasonic vortex-sensing technique enables the VA-320 to register accurately the faintest breeze or 134-mph winds. With somewhat reduced accuracy, its speed range extends to 179 mph. The anemometer has already followed its larger predecessors aboard scientific buoys. J-Tec, 317 7th Ave. S.E., Cedar Rapids, Iowa 52401.—*John Free*



Wind entering vane tunnel flows around strut, developing a series of air vortices. The number of vortices formed each second varies directly with wind velocity. Each vortex pair passing through an ultrasonic beam scatters and modulates the beam (bottom). Circuits can then register vortex count on a mph meter.

...And the Best of Canada.

Here's a new way to get authentic goods from the North Country... items that are not readily available in local stores.

Chamois Cloth Shirt. Long sleeves and long tuck-in tails. (Ladies' has squared tails.) Warm, durable and machine washable. Colors: Forest green, Tan, Navy, Bright red. Men's sizes: 14½ to 19 Ladies' sizes: 10 to 20. $12.50

Early American Trapper Blanket. 85% wool, 15% nylon for durability. 72" x 90". Machine washable. Patterns: White with candy stripes, Red with black stripes, Green with black stripes. $26.75

Old-fashioned Scarlet Union Suit. For active outdoor men and women. Duofold soft cotton inside with wool, cotton and nylon outer layer. Sizes: 34-36-40-44-48. $17.50

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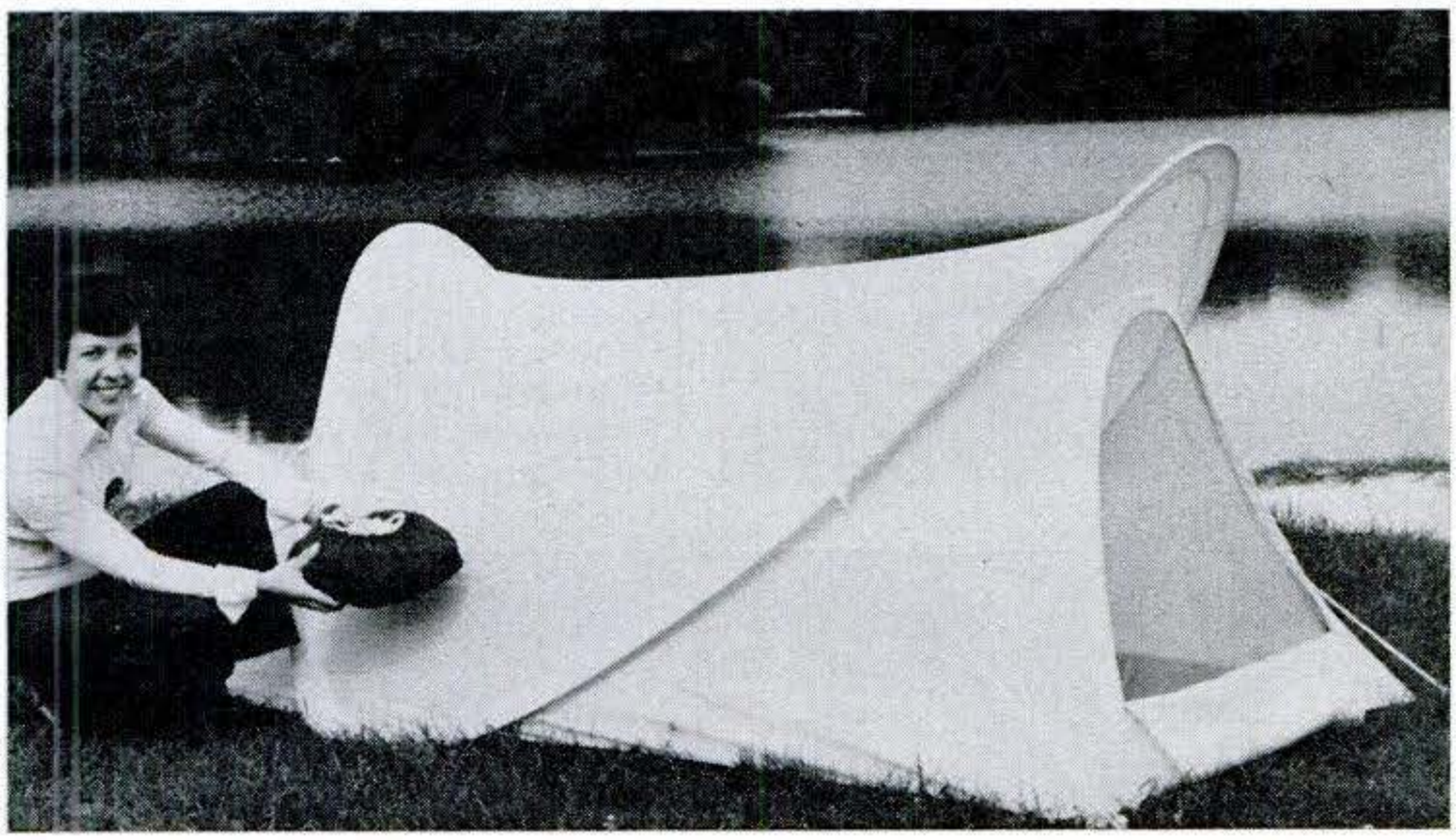
Outdoor gear
for wilderness wandering



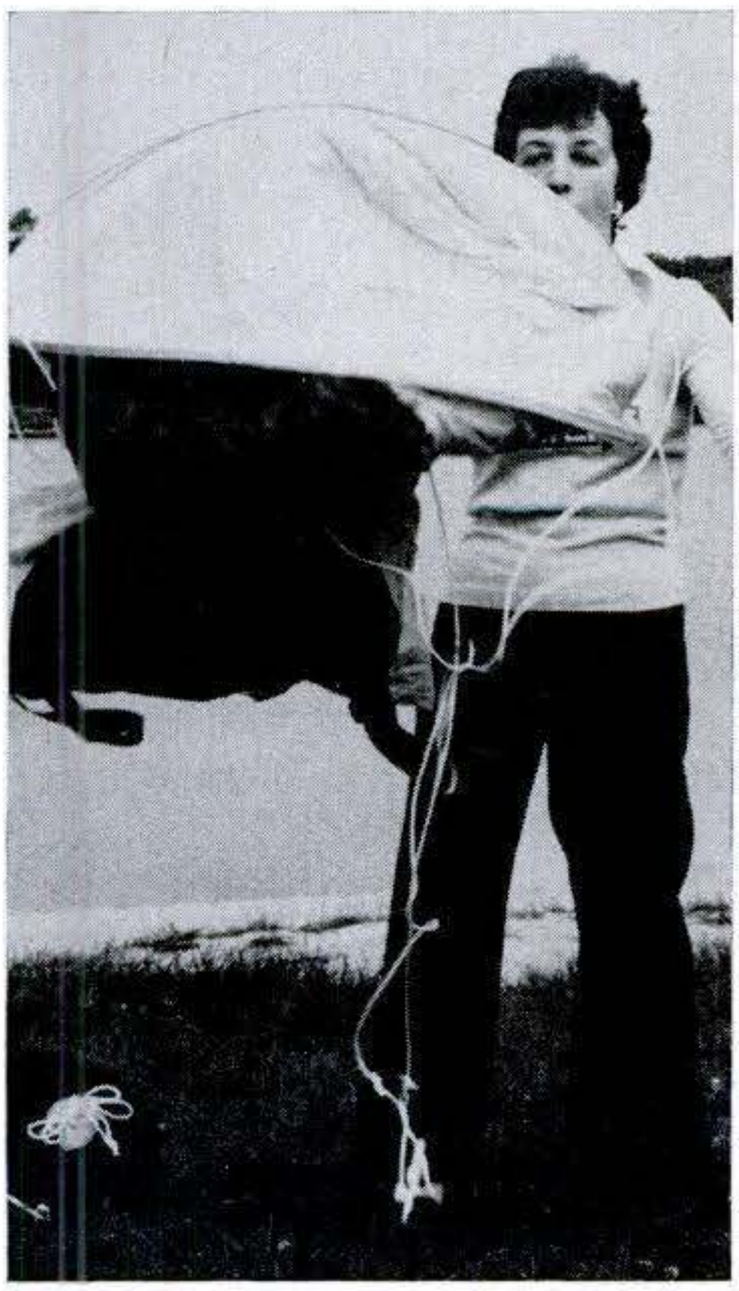
By V. ELAINE SMAY

Clever engineering is improving the quality of many camping and backpacking items that make wilderness trips more pleasant. These design improvements make today's gear compact, lighter, easier to carry.

I recently surveyed the new outdoor gear produced by some 50 manufacturers, and prowled lots of camping-equipment stores to discover what's new for '77. I found many improvements—some subtle, some basic. New materials are used for some standard products, and there are a few completely new items. I narrowed my choices to the gear you see on these pages.

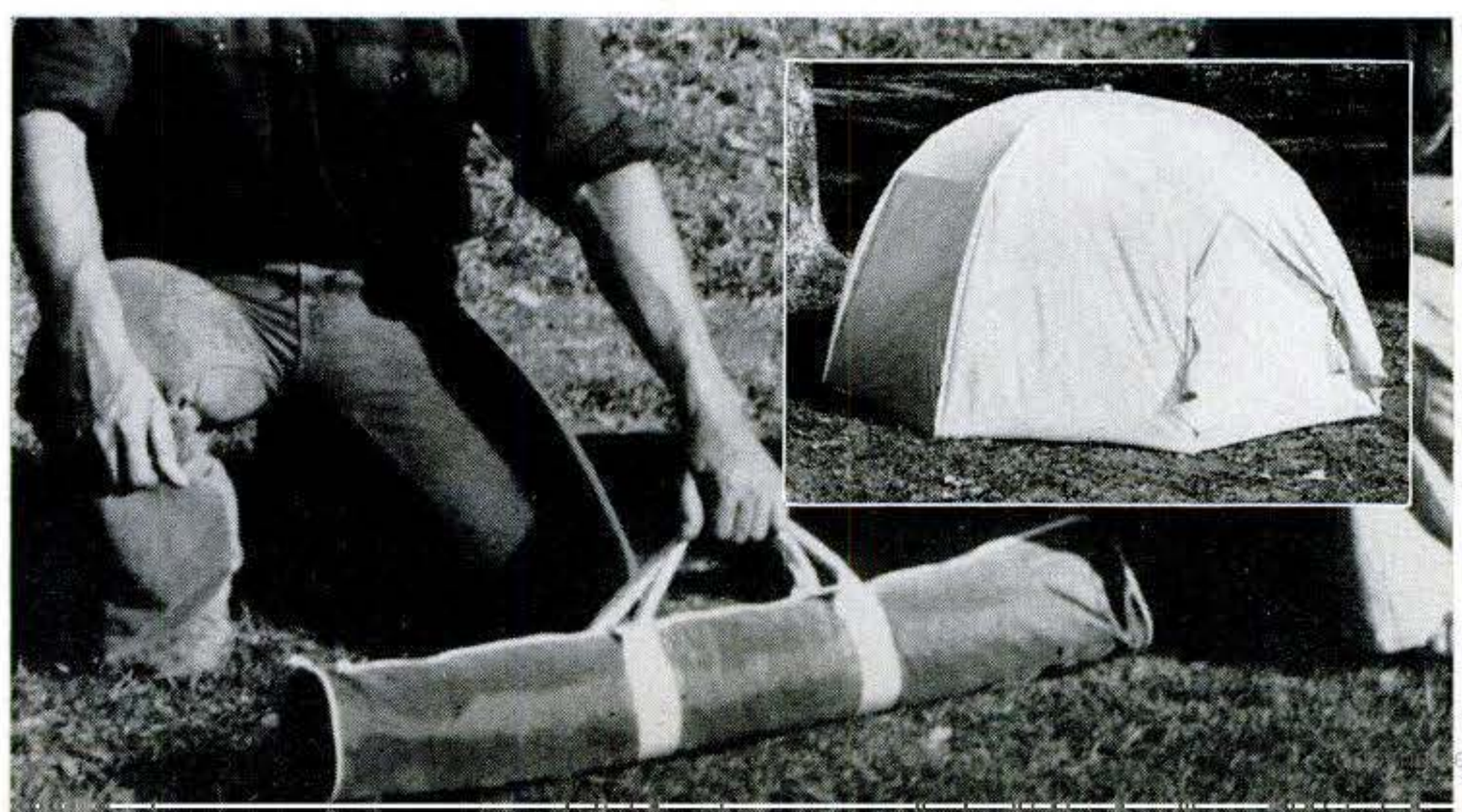
In general, the new gear shows a trend toward even more comfort and convenience, more versatility, and lighter weight. And those are qualities that separate happiness from hassles when you leave home and hotel to catch a breath of wilderness. PS

More outdoor gear on next page



Instant tent pitching? Just about. Two-man Fastent (Upland Enterprises) has integral supporting frame made of a continuous loop of spring steel. Release it from its compact stuff sack and the coiled frame springs out (below, left). Pull it taut, stake the corners—voila, your tent is pitched (above). Deluxe model, $155; standard, $130.

Ten-Second Tent from Sunshine also has built-in frame that lets you erect it in an instant. Just pull an interior rope and the steel frame opens the tent like an umbrella. Packed weight, 4½ lb.; price, about $135.



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Enjoy all the benefits of a compact tiller... spring-steel tines, tilling widths from 7 to 22 inches, lightweight fold-down design for easy transport and storage, easy to use... plus the extra pleasure of converting it to a little walking tractor. Remove the tines, attach the steel wheels and you're ready to cultivate, furrow or hill. It's the complete gardening machine that makes light work of tilling and cultivating.

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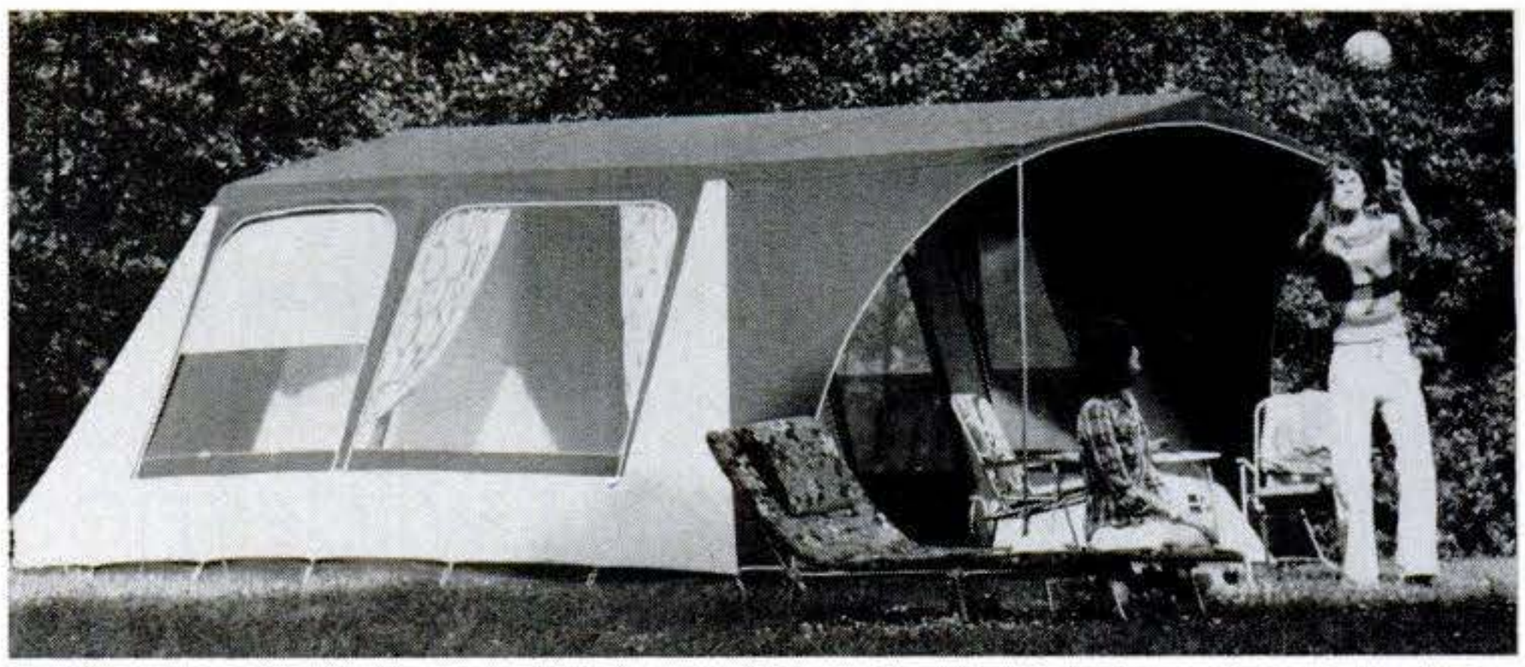
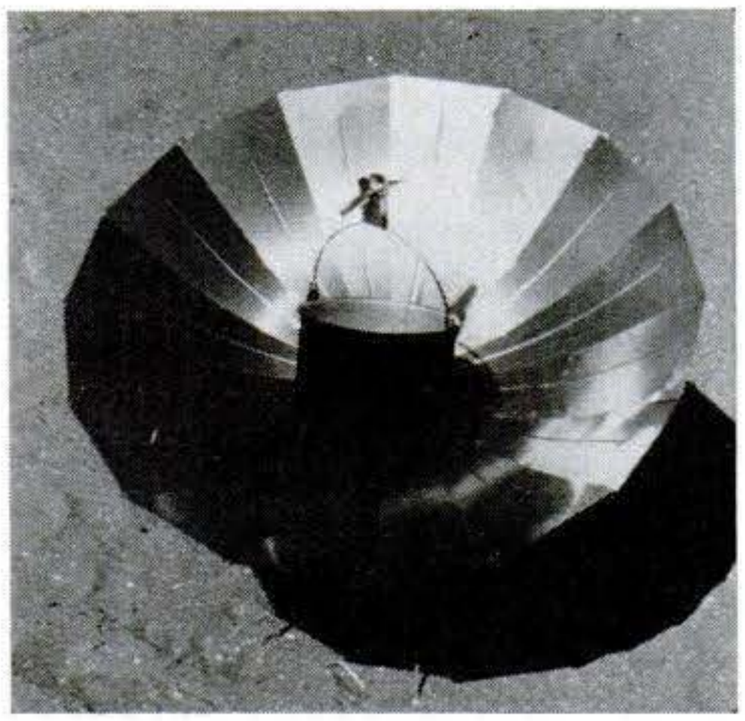
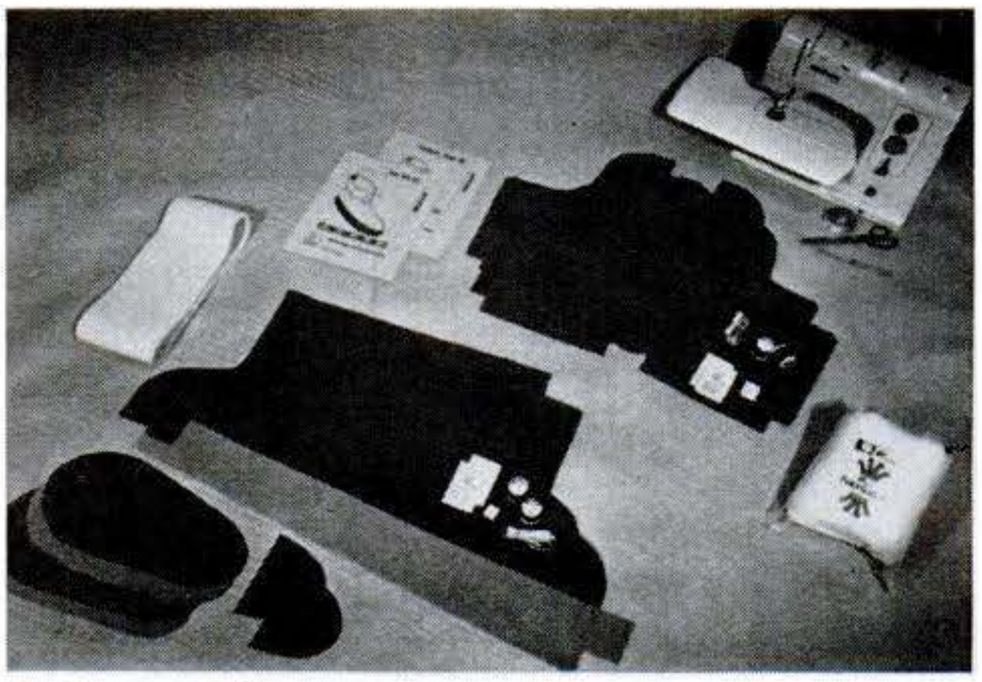




Deluxe family tent has two sleeping cabins, wardrobe pole, curtains on the windows. Made by Mehler of Germany, it's 400 by 440 cm, 205 cm high. $599.

Let sunshine cook your lunch: Six-foot-square reflector folds for packing; stand adjusts to let you follow the sun. Sunpak Solar Cooker ($25 from E-Z Sales) can boil two cups of water at sea level at 9 a.m. in 13 minutes.

Compact cylinder contains stove, butane cartridge, two pans, and handle. Globetrotter from Wonder Corp. is $25; cartridges (one lasts an hour) are 99¢.



With a DIY kit you can stitch together your own gear. Booties shown have Polarguard (fiber-fill) inner boot ($5.50) for wear inside tent, sleeping bag; overboot ($6.50) for outside wear. From Mountain Adventure.

For more outdoor gear, turn to page 60

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Thunderbird for 1977.
At $5,434,*
it's hard to believe.

Thunderbird. Leaner, cleaner and 10 inches trimmer in size. Its refined suspension system and wide stance mean you can expect agility and sureness to complement Thunderbird's legendary quality and comfort.

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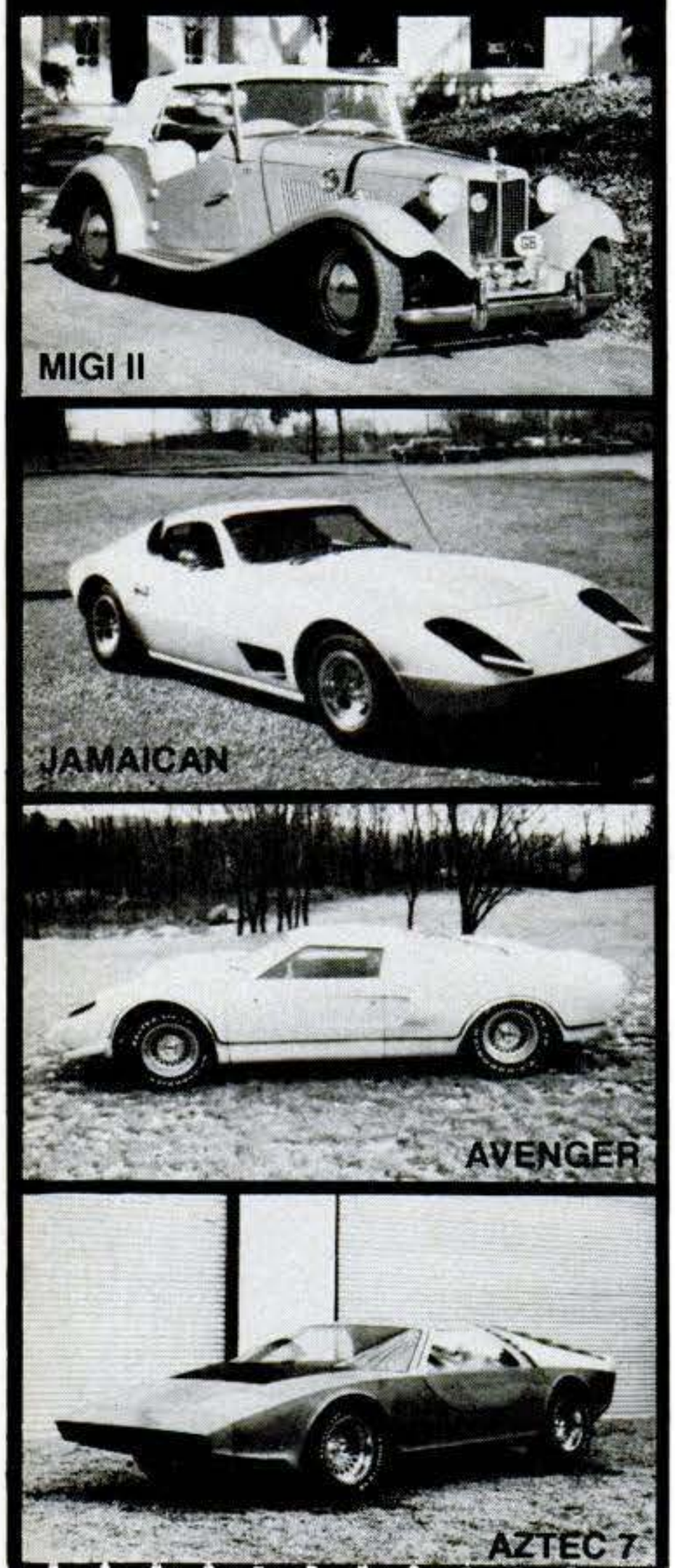

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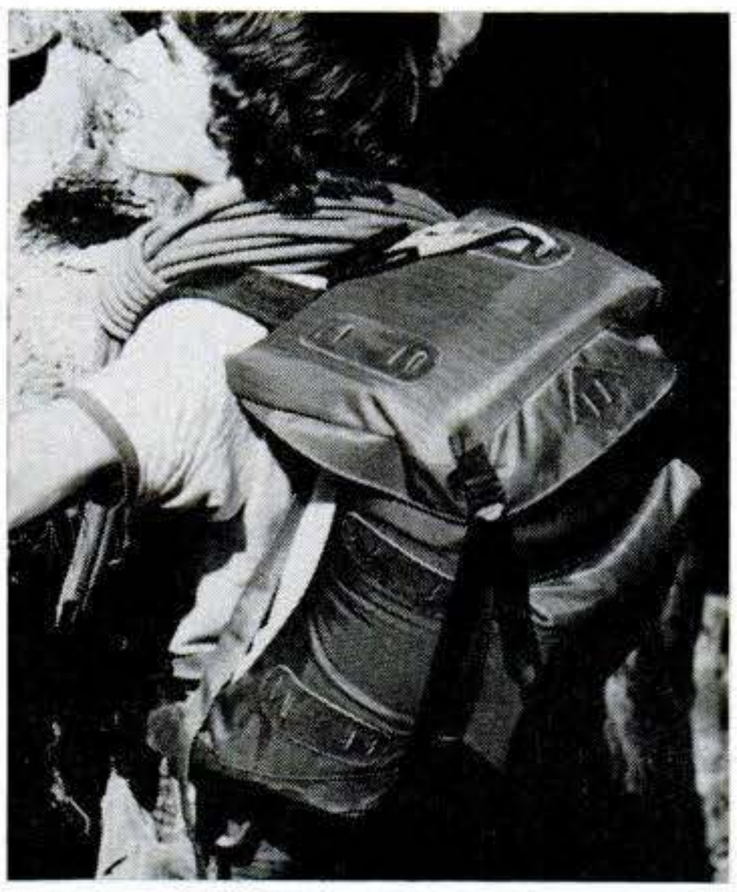
For all-weather camping, try The System from Camp 7: Start with a basic down sleeping bag—good for cool-weather camping. Insert it into the Pioneer, a two-lb. Polarguard synthetic sleeve, to add loft for extra-cold conditions. Since Polarguard, unlike down, keeps its loft when wet, you also use the sleeve to isolate your bag from damp ground, snow, or ice. For even more warmth, slip a vapor-barrier liner inside the down bag to prevent evaporative heat loss. Polarguard sleeve alone is ideal for summer camping (above 45°F). The Pioneer is $36.50; vapor barrier, $14; down bags that fit into sleeve are available in a range of prices.

Good for kids, this pack carries a sleeping bag, plus a little more. Kelty; $9.

Fanny pack wraps around waist, rides on hips; leaves arms, shoulders, back completely free—and cool. You can stow extra clothing, photo gear, lunch, in its 700 cubic inches. Foam lining adds comfort and rigidity. $25 from L. L. Bean.

Polypropylene pack frame from Coleman can be fit with any of four packs. Top-of-the-line pack shown ($57.50 including frame) has removable fanny pack (top compartment) for day trips. Just take it from the frame and hook it to the pack's waist belt. Frame adjusts so one size can fit most hikers.



Wraparound Stag soft pack keeps load close to your center of gravity—ideal for ski touring and backpacking. Interior foam pad protects your back. It's $37.50.

WHO MAKES THEM

Camp 7, 802 S. Sherman, Longmont CO 80501; **Coleman Co., Inc.,** 250 N. St. Francis, Wichita KS 67021; **E-Z Sales and Mfg., Inc.,** 1566 W. 134 St., Gardena CA 90249; **Kelty Pack, Inc.,** 9281 Borden St., Sun Valley CA 91352; **L.L. Bean,** Freeport ME 04033; **Mehler Tents,** imported by Enterprise Distribution Inc., 99 W. Essex St., Maywood NJ 07607; **Mountain Adventure Kits,** Box 571, Whittier CA 90608; **Stag Trail Country by Hirsch-Weis,** Div. of Warnaco, Inc., 5203 S.E. Johnson Creek Blvd., Portland OR 97206; **Sunshine Cover & Tarp, Inc.,** 20310 Plummer St., Box 806, Chatsworth CA 91311; **Upland Enterprises, Inc.,** 426 Mt. Auburn St., Cambridge MA 02138; **Wonder Corp. of America,** 24 Harborview Ave., Box 1402, Stamford, CT 06902.

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Ride full tilt into the 40 channel era with the new White Knight CB Antenna. And take the Shakespeare performance route home.

The White Knight Antenna, Style 4125/available in a variety of pre-assembled mounting styles. Complete with cables and connectors. Under $25.

Shakespeare

Coming on strong for the Knights of the Road.

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ON TARGET

By PAUL WAHL

Two new Brownings

With a similar receiver profile and stock design, the new Browning BAR 22 (above) looks a lot like its centerfire namesake, the Browning BAR High Power sporting rifle. This is a man-sized .22 autoloader weighing six pounds, four ounces. It's chambered for the Long Rifle cartridge, and has a full-length tubular magazine holding 15 rounds. Among the BAR's features are a simple takedown system, 20¼-inch barrel, combination firing-pin/ejector, and a cross-bolt safety at the center of the trigger guard. Southpaws can get a left-hand safety. Standard sights are a ramp-based gold bead up front and an adjustable folding leaf rear; the receiver is grooved to take standard scope mounts. Stock and forearm, nicely checkered, are of French walnut.

Browning's other new .22 is a pump, the maker's first rifle with this type of action. It should be welcomed by shooters who prefer repeaters trombone style. These days, there are only a few .22 slide-action rifles on the market. This pump comes in two versions: Model BPR 22 for .22 Long Rifle and Model BPR 22 Mag handling the more powerful .22 Winchester Magnum Rimfire cartridge. Magazine capacities are 15 and 11 rounds, respectively. The BPR's forearm doubles as a slide handle for operating the action; otherwise, it and the BAR 22 are identical.

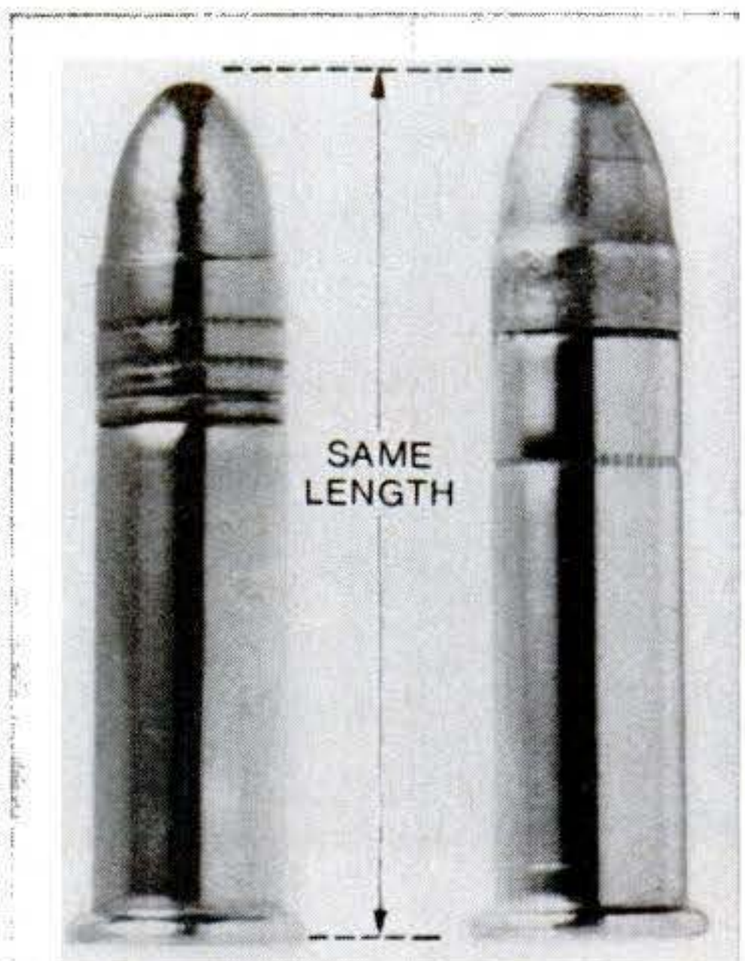
The suggested retail price of $159.95 applies to the BAR 22 as well as both the BPR 22 and BPR 22 Mag. These are among the better rimfire sporters available—handsomely well-built examples of today's Japanese gunmaking. From Browning, Morgan, Utah 84050.

.22 Stinger

Arriving just in time for the spring-summer varmint season, this potent new rimfire from CCI is the hottest round that you can load into a .22 Long Rifle chamber. The .22 Stinger drives its 32-grain hollow-point bullet at a muzzle velocity of 1640 feet per second, delivering 202 foot-pounds of muzzle energy. Compare these numbers with 1280 fps and 135 ft.-lb. for the conventional high-speed .22 LR with 37-gr. hollow-point bullet.

Its higher velocity makes the Stinger shoot flatter: Bullet drop at 100 yards is 3½ inches less than for the high-speed .22 LR. The lighter Penti-Point bullet has a deep cavity and the five corners of the pentagonal hole in the point help the lead to peel back, causing the bullet to "explode" on impact for a devastating effect on the target. Should you miss and hit a rock, there's less danger of ricochet, because of this tendency of the bullet to break up.

To accommodate the heavier charge of slower-burning powder developed especially for the Stinger, its nickel-plated case is approximately 1/10-inch longer than that of the .22 LR. However, the overall lengths of the two rounds are the same and, according to its manufacturer, extensive testing has proved that the Stinger will function reliably in any modern firearm chambered for the .22 LR cartridge. It's claimed that breech pressure for the Stinger is well within ammunition-industry standards for high-speed rimfires.



Regular .22LR Stinger

The .22 Stingers come in boxes of 50 priced at $1.95. Made by Omark Industries, Sporting Equipment Div., Snake River Ave., Lewiston, Idaho 83501.

Update

● Lee Load-All [July, 1976]: Now virtually any shotshell load can be duplicated with the improved Load-All. It has a new charge bar with 24 shot and powder bushings; 12-, 16- and 20-gauge models are available. Price still is only $29.98. An $8 charge-bar kit converts the 1976 Load-All to the latest version. Lee Precision, Inc. (Hartford, Wis. 53027), offers a complete line of good, low-priced tools for reloading rifle, handgun, and shotgun ammo. A catalog is 25¢.

● 7-mm Comeback [November, '76]: As several readers wrote to tell me, the Savage Model 111 isn't the only domestic sporting rifle currently chambered for the 7-mm Mauser cartridge. The Ruger Model 77R, at $225, comes in this caliber, too. Manufacturer is Sturm, Ruger & Co., Inc., Southport, Conn. 06490.

Stock treatment

Stock Slick is a new liquid cleaner-reconditioner-preservative for gun stocks. You spray it on the wood, wait a few minutes for it to dry and then, with a dry soft cloth, polish to a luster that brings out the beauty of the grain. Besides cleaning and reconditioning the wood, Stock Slick protects against moisture and also resists dust that often accumulates on guns displayed or in storage.

Priced at $2.25, Stock Slick comes in a six-ounce aerosol can. It's available from dealers or from Totally Dependable Products, 513 High St., Pottstown, Pa. 19464. Add $1 for shipping.

New books

● Rarely do I come across a book that rates a rave as does Ludwig Olson's *Mauser Bolt Rifles*. Handsomely produced, this lavishly illustrated, large-format book of 364 pages is the definitive work on the history and development of the famous Mausers, replete with technical data and other information unavailable elsewhere. I think it's a real bargain at $24.95. From Brownells, Inc., Rte. 2, Box 1, Montezuma, Iowa 50171.

● *America's Great Outdoors* is a big, beautifully illustrated anthology of some of the best of 200 years of outdoor writing. There are 367 pages, 8½x11, more than 400 illustrations, and 48 pages of color paintings and photos. The bicentennial project of the Outdoor Writers Association of America, it was edited by L. James Bashline and Dan Saults and is published by J. G. Ferguson Co., 111 E. Wacker Dr., Chicago, Ill. 60601. Price: $24.95. PS

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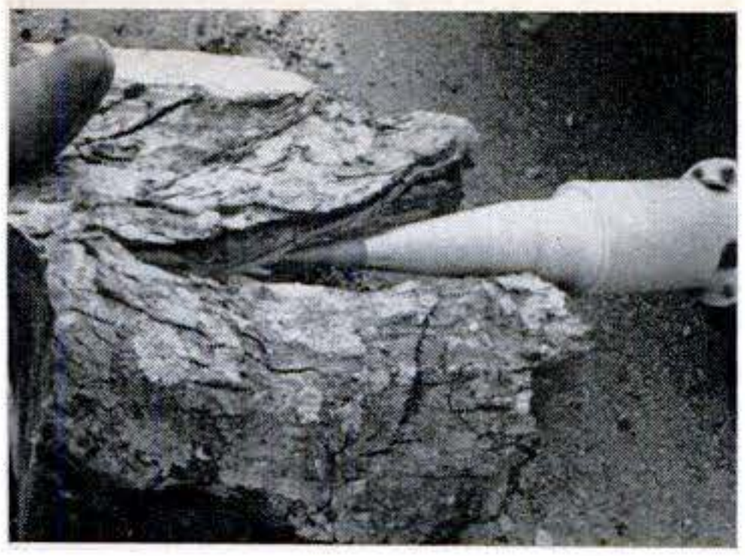
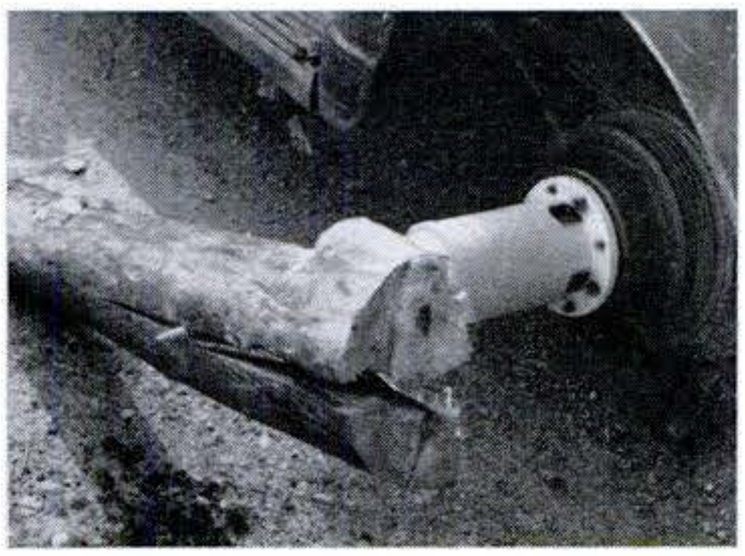


Author's test shows Stickler capable of handling huge burls like this, though Splitter is recommended for logs 28 in. in diameter by 30 in. long.



Tip of the Stickler keeps itself sharpened as it side-spins against this well-seasoned sugar maple. Log is split in a few seconds as thread bites into wood.

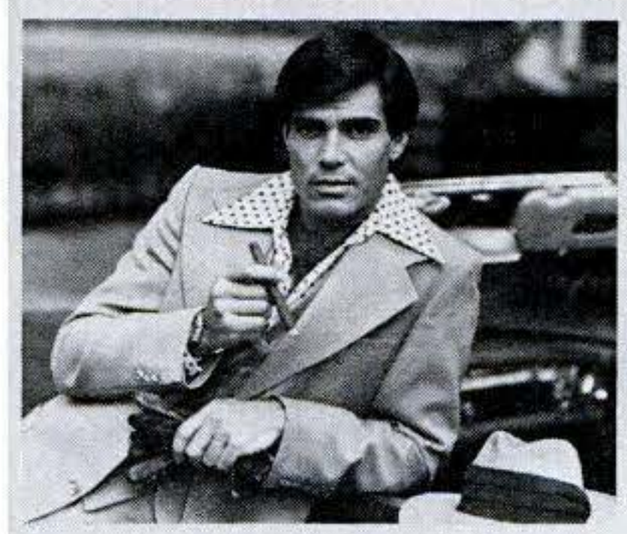
Car-powered logsplitter

Gas up your car if you want to make firewood with this log splitter. The car-powered Stickler is a large screw, available in sizes that fit the drums of most light trucks and cars.

For my test, I jacked up the left rear axle of a 1950 Chevy pickup (setting chocks against the other three tires), and bolted the Stickler to the hub of the raised wheel. I hooked up the saftey switch (it lets you kill the engine from outside the vehicle), and rolled up a huge burl of well-seasoned sugar maple—all large knots from the first branching of the tree. The log was wedged up tightly to the tool at a 45° angle to the ground; the idle of the Chevy was turned to between 1200 and 1500 rpm. I stepped back, and the oversize burl was two halves in a matter of seconds. The thread of the screw bites into the log and works its way through to the opposite end.

The Stickler works better than the maker claims; I tested it successfully with logs well over the stated capacity of the tool. It's made by Taos Equipment Mfg., Inc., Box 1565, Taos, N.M. 87571. Price is $199.—*Charles Self*

HOW TO FEEL LIKE A MILLION.



Nothing gives a man more of a touch of class than taking a cigar out of a tube. And there's no better tubed cigar for the money than Royale by Gold Label. A stylish cigar with a rich Cameroon wrapper. And all the mildness and freshness sealed in by the tube. So take out a Royale and take on the look of a millionaire.

ROYALE *in a tube*
by Gold Label

South Carolina.
It's a lot of great vacations.

Whatever kind of vacation you're looking for, you'll find it in South Carolina.

And to help you plan your vacation, we'll send you the new South Carolina Trip Kit—free! It'll tell you about things to do and places to stay. And there are maps to show you how to get there once you get here.

Wherever you go in South Carolina, you'll find a lot of great vacations. Just clip the coupon to find out how they can all be yours.

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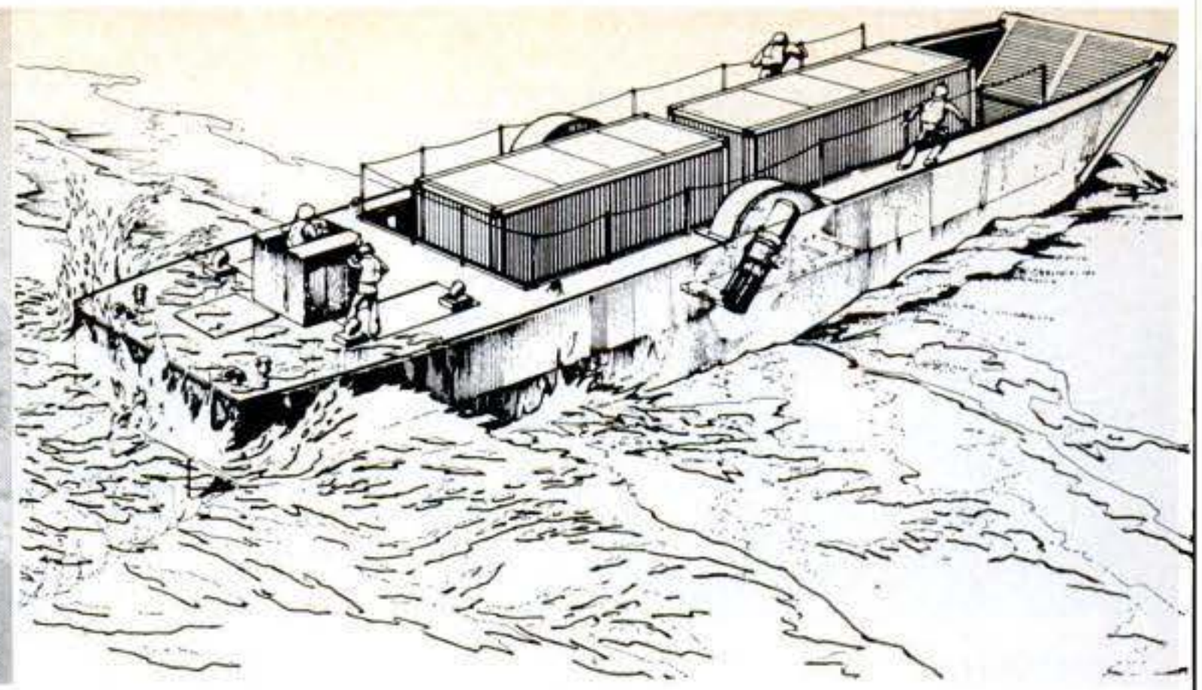
Beached, but not stuck, this test craft has counter-rotating weights in its center to back it off the sand.



Powerful pistons, retrofit to hull of Marine landing craft, will move ship right up onto a beach for safer unloading.

You can't trust a machine to make a great knife.

People make great knives. Machines can't. Each Schrade Old Timer is made with over 100 hand operations. And each hand operation is carefuly inspected. For a great knife you can trust, Schrade Cutlery Corp., New York 12428.
Made in U.S.A.

Old Timer® by Schrade

94OT Gunstock Trapper

Beach and launch unit

lets ships "walk" on land

"It's such a peculiar sight to see that 20-foot boat moving across the sand," Dr. Howard Gaberson of the Civil Engineering Laboratory told me. He was describing the successful test of the CEL's new Beach and Launch Unit. The BLU allows flat-bottomed boats to run right up on a beach, then "walk" back into the water.

Reciprocating weights make it possible. The weights are simply pistons mounted in the boat's hull. Although they're fired by the boat's fuel supply, the pistons work independently of the engine. By adjusting the pistons' tilt and firing them either separately or together, a pilot can generate a shuffling motion strong enough to actually move a ship across the ground.

It works like this: At the top of each piston stroke, the boat is pulled slightly forward; at the bottom of the stroke, the weight forces the boat downward. Friction keeps the craft from sliding backward. This simple back-and-forth motion can move a ship onto or off the land—while the engine is shut down.

Designed for the U.S. Marines, the BLU should make for less hazardous landings of men and equipment. It also has possibilities for civilian use: Supply ships fitted with Beach and Launch Units could easily load and unload in remote areas that have no proper docking facilities. In fact, says Dr. Gaberson, the offshore oil industry is already interested in looking at a BLU for its marine operations.—*Susan Renner-Smith*

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Putting the accent on comfort made Volaré America's best selling wagon.

The proof is in the putting. And we put more value into Volaré than any wagon lover could ever rightfully expect. Put one through its paces. Discover for yourself the best-selling combination of size, comfort and economy that leaves Volaré virtually without competition.

Volaré offers more cargo space than other small American wagons. Other small American wagons in Volare's class just aren't. Comparisons don't exist. Better you should compare Volaré to big station wagons (83% as much space as a Chevrolet Impala wagon); or mid-size wagons (more passenger space than a Chevelle wagon). Pinto? Pacer? C'mon.

24 mpg/ 17 mpg. Volaré puts out some pretty impressive EPA estimates for highway and city driving, based on 6-cylinder 2-barrel engine and manual transmission. Your mileage could differ depending on how and where you drive and your car's optional equipment, and will be lower in California and certain other areas. But considering Volare's huge cargo capacity, 24 and 17 are nothing short of fantastic, sensational and terrific. To put it mildly.

The liftgate is gas assisted for ease of operation. At various times there have been 1-way tailgates, 2-way tailgates, 3-way tailgates, even vanishing tailgates. Everybody tries to design their own tricky way to get into the cargo area. But the test of a good tailgate is simply this: It should work. It should get out of the way in a hurry, yet close easily and efficiently. (Volare's does.) What it shouldn't do is pad out the price with rattle-prone gadgetry. (Volare's doesn't.)

Volare's isolated transverse suspension. Underneath the comforts of room, size and price is a ride that compares favorably to big wagons. It results from isolating, bending and mounting torsion bars in transverse fashion. Given time, other wagon makers may someday duplicate Volare's isolated transverse torsion bar suspension. Maybe. Someday.

Hidden spare tire and lockable storage compartment. The difference between Volaré and other small wagons is that it doesn't just pretend to be a wagon. Like big wagons, the spare tire is under the cargo floor, out of sight. And, like big wagons, there's a hidden storage compartment on Premier models to keep that "out-of-sight" camera out of sight.

Even the price is comforting. It all comes down to price. And it's our contention, nobody has more features coming down on a lower price than Volaré. Just $3941* for the base Volaré Wagon to your left. The Premier model shown above is, of course, more expensive. Putting the accent on comfort paid off. It has more people putting their money on Volaré than any other wagon in America.

Plymouth

A PRODUCT OF CHRYSLER CORPORATION

*Manufacturer's Suggested Retail Price excluding: taxes, license, destination charges, whitewalls ($39.25) and deluxe wheel covers ($32.00). Prices higher in California.

Volaré. The small wagon with the accent on comfort.

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Porta Potti Continental.™

Take-along convenience for boat, RV, tent, cottage.

Makes the great outdoors just like home for your wife and children. The Continental is a fresh-water flush portable toilet that tucks into camper, van, any car or station wagon. Measures only 18½" x 18½" x 14¾" high.

Porta Potti® is the original fresh-water flush portable toilet.

Almost double the capacity. Compare. Continental has the largest waste holding tank capacity. Meets the needs of a family of four for a long weekend. Needs to be emptied only about half as often as most other portable toilets. Just detach holding tank and empty into any permanent toilet.

No odors. No spills. Waste holding tank valve closes automatically when you release the exclusive spring-loaded foot pedal.

Exclusive padded lid. Soft padded top and comfortably shaped lid let you use Continental as an extra seat. It's rugged, trim and smartly designed. In decorator colors.

Smooth, easy to clean exterior. Like the toilet in your home, Continental's smooth exterior wipes clean in a jiffy.

Continental for lasting value. Make sure you get the capacity, durability and convenience features you'll want for lasting satisfaction. Insist on Porta Potti Continental by Thetford.

Show this ad to your wife. Then send the coupon for complete information on Porta Potti toilets and accessories, including a list of dealers in your area.

THETFORD CORPORATION
P.O. Box 1285A-3
Ann Arbor, Michigan 48106

Send me more information on Porta Potti portables, including dealer listing.

Name_____

Address_____

City_____ State_____ Zip_____

The Continental by **THETFORD**

Minilo is shown with its blade pushed out so you can see it. The base is spring-loaded; normally, the blade is recessed when it's not cutting. Wooden case and several accessories are included in the Minilo package.

Swiss spliner

–fast, easy operation gives strong, accurate joints

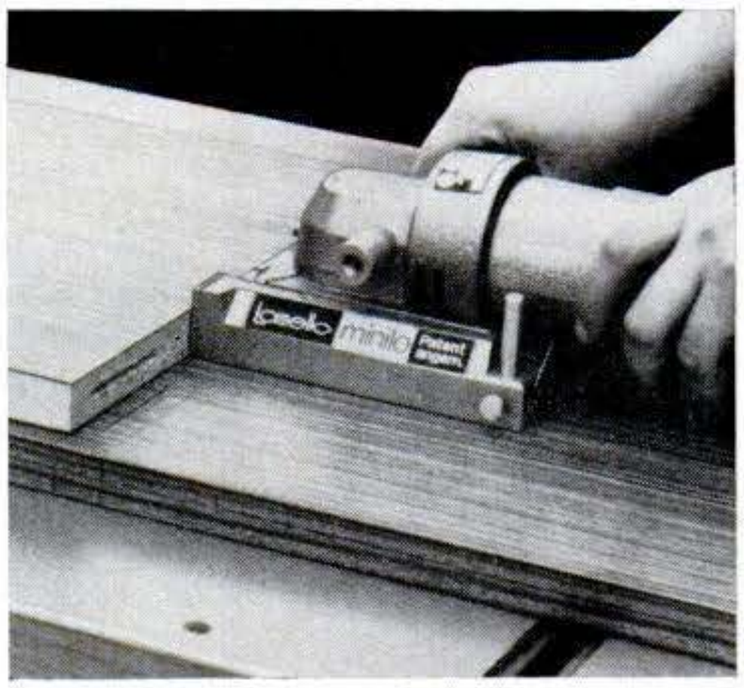
Lamello-Minilo, a sweet new Swiss system for joining wood, is based on a special oval-shaped spline, the Lamello. Made of compressed, dried beechwood, the Lamello swells when glued to fit super snugly in its groove. This gives it great strength; and, of course, like any spline it provides a large gluing surface.

The Minilo is basically a router with a carbide-tipped wing cutter nestled inside a rectangular sliding base. You hold the front edge of the base against the wood—a pair of sharp points keeps it from slipping —then push the motor. That shoves in the cutter.

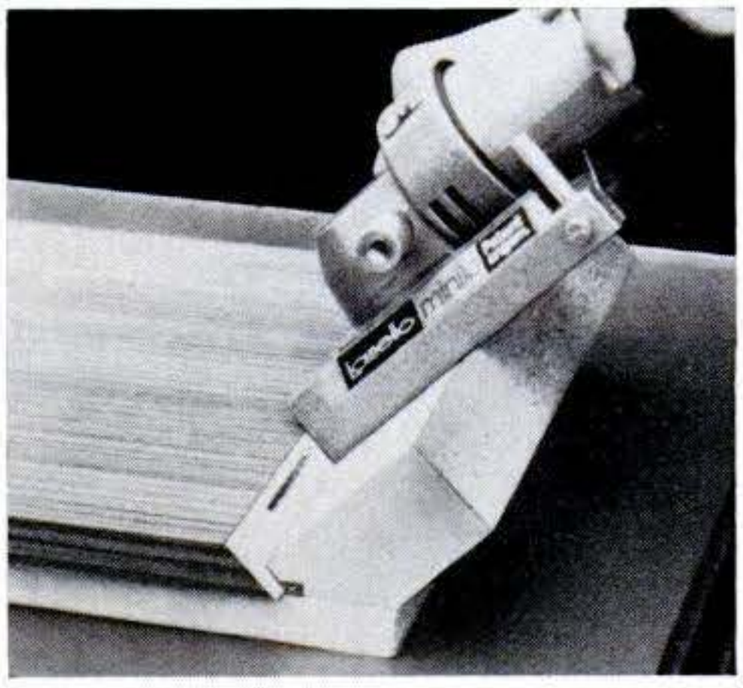
To see how simple it makes joinery, let's walk through a complicated job that could take you an hour to dowel—say a four-paneled door with a mitered frame. With the Lamello-Minilo, you choose one of three sizes of spline, and insert the appropriate spring clip in the machine to set depth of cut. Next lay all the parts face down on your bench and mark roughly where the joining will go. Finally, push the machine into the wood everywhere you've marked. That's all there is to it, besides gluing up the pieces.

I've come across very few situations where I couldn't use the Lamello-Minilo to save a lot of time. Cabinet carcasses, framed or solid doors, table tops or pedestals, butt, mitered, or chamfered joints—the spliner does them well.

Price of the tool is—alas—$380, with case, accessories, and a few dozen 2½¢ splines. Colonial Saw (100 Pembroke St., Kingston, Mass. 02364) sells it.—*Charles E. Maurer.*



Neat, strong carcass joint, such as this one, can be made by Lamello-Minilo in less time than it would take to screw the boards together.



Jig makes mitered edge joints a breeze. It's the only jig you'll need with the Minilo; the tool automatically cuts grooves dead true.

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Laser welding
for tricky jobs

Tools for inspecting jet-engine bearings are minute compared to dime. Laser welds join the tiny ball bearings to the steel tips of screwdriver shafts.

In a careful balancing act, a laser technician prepares to weld a ball bearing to a shaft. Bearings used range from 1/32 to 3/16 of an inch.

Once an esoteric laboratory device for physicists, the laser has become a familiar tool. Its latest home is the machine shop. At Tinker Air Force Base in Oklahoma, technicians now use lasers for precision welding jobs.

Engineers realized the welding potential of the laser a few months ago. Jet-engine inspectors at the base wanted a simple tester to check the interior dimensions of reworked bearing races. The tool needed was a single tiny ball bearing attached to a handle. The handle was easy—a ground-down watchmaker's screwdriver. The problem: sticking the ball bearing to the handle's tip.

Regular welding dissolved the bearing, and neither solder nor a special glue was strong enough. So engineers tried the laser. Using it at low power (about 1800 volts), they zapped the ball bearing four times, creating four tiny, super-strong welds.

Who knows? By 1984, lasers may be "must-have" items in the home workshop.—*Susan Renner-Smith*

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Two-way improvement

New fold-down RV antenna provides full 40-channel capability. Also available for luggage racks.

Has your CB ever let you down? Right when you needed it the most?

It could be that "good deal" antenna. Or the lightweight mike that came with the set. To get the most out of your CB, switch to Turner at both ends.

Try a Turner amplified mike. You'll find out how much talk power your set can really deliver. For full range when you need it.

Make sure your antenna is dependable. Step up to a Turner. Turner builds them tougher. There are 43 models for all kinds of base and mobile installations.

Ask anybody who has been around CB for awhile. They know us. Wherever CB is sold, Turner.

The talk of the road

TURNER

MICROPHONES
ANTENNAS

CONRAC CORPORATION 716 Oakland Road N.E., Cedar Rapids, Iowa 52402

Deep ocean sampler

Scientists have long been able to study microorganisms that live in the high-pressure, low-temperature depths of the ocean, but only by exposing them to surface conditions. Now researchers at the National Bureau of Standards and the University of Maryland have developed a sampler that will encapsulate a deep-ocean sample, seal it off from the outside world, and bring it to the surface alive in its own mini-environment.

The pressure vessel used is made of heat-treated stainless steel. A Teflon coating on the chamber inside inhibits any biological reaction with the sample. After the sterilized sampler is deployed to testing depth (deepest so far is 6800 meters) a program timer is actuated. A check valve equalizes internal and external pressures, then sea water is pumped through two valves. The sample, quickly hoisted to the surface, is immediately refrigerated. In the lab, droplets of the sea sample are removed to be studied under an electron microscope. Nutrients fed into the chamber's capillary system replace the droplets and maintain the original pressure.

What are researchers looking for? New information to help determine if microorganisms that inhabit the ocean depths can carry out metabolic reactions to assist in the breakdown of substances dumped by man into the sea.—*N. Smith*

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No other TV/Audio home study school puts prices in its ads. Why?

Maybe it's because they can't match these values

NRI will give you complete TV/Audio service training with a solid state 25″ diagonal color TV and a 4-speaker Quadraphonic System for hundreds of dollars less than the combined tuition cost of courses at another school. Only NRI gives you a choice of five ways to learn, starting as low as $445 with convenient, inexpensive time payment plans.

NRI pays no salesmen. We buy no outside "hobby kits" for our experiments and training kits. We pass the savings on to you, giving you the top educational value available anywhere.

Take your choice in TV/Audio training

Only NRI gives you a choice of five courses in TV/Audio servicing. Each comprehensive course features bite-size lessons, special reference texts, special engineered "power-on" training kits, and service instructions for black and white TV, color TV, FM multiplex receivers, PA systems, antennas, radios, tube, digital circuitry, transistor, and solid state circuits.

NRI SCHOOLS
McGraw-Hill Continuing Education Center
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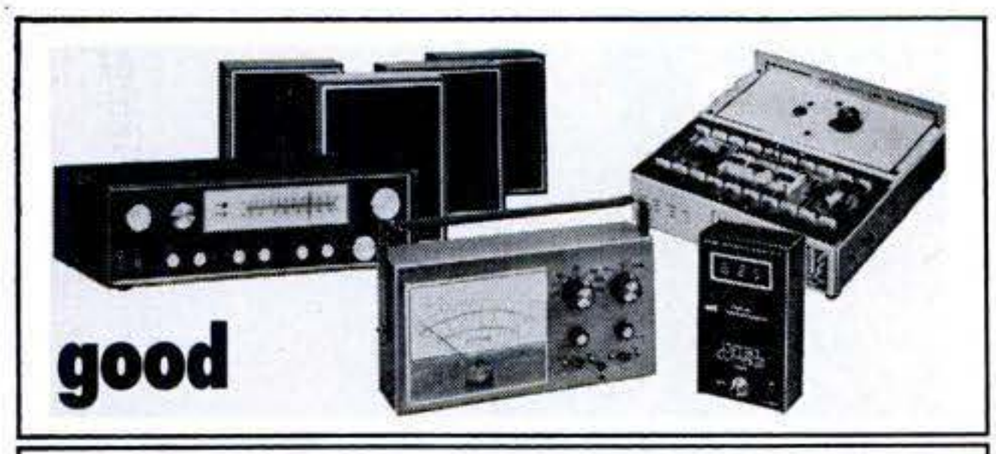
Washington, D.C. 20016



7 kits including Quadraphonic Stereo...$445 or low monthly terms

A basic TV/Audio Servicing Course including 7 training kits for your experiments. You build your own 4-speaker Quadraphonic System, solid-state volt-ohmmeter, CMOS digital frequency counter, and electronics Discovery Lab. Includes 48 bite-size lessons (18 on color TV), 10 special reference texts with hundreds of servicing shortcuts, tips on setting up your own business, etc. This completely up-to-date course covers black & white and color TV, FM multiplex receivers, public address systems, antennas, radios, tube, transistor and solid-state circuits.

11 kits with Quadraphonic Stereo and B/W TV...$550 or low monthly terms

A complete course in B&W and Color TV Servicing, including 48 lessons (18 on color TV), 10 special reference texts and 11 training kits. Kits you build include 4-speaker Quadraphonic System, solid-state volt-ohmmeter, CMOS digital frequency counter, electronics Discovery Lab, plus a 12″ diagonal solid-state black & white portable TV to build and use. At each assembly stage, you learn theory and "Power-On" application of that theory in typical solid-state TV sets.

11 kits with 19″ diagonal color TV...$880 or low monthly terms

The course includes 42 lessons and 4 reference texts plus kits and experiments to build a superb solid-state 19″ diagonal color TV receiver . . . complete with cabinet, and engineered specifically for training by NRI's own engineers and instructors. This handsome set was designed from the chassis up to give you a thorough understanding of circuitry and professional trouble-shooting techniques. You build your own solid state volt ohmmeter, CMOS digital frequency counter, and experimental electronics Discovery Lab.

14 kits with 25″ diagonal color TV and Quadraphonic Stereo...$1195 or low monthly terms

The ultimate home training in Color TV/Audio servicing with 48 bite-size sessons, 10 reference texts, and 14 training kits . . . including kits to build a 25″ diagonal color TV, complete with console cabinet; a 4-speaker Quadraphonic Center; a wide band, solid-state, triggered sweep, service type 5″ oscilloscope; digital integrated circuit color TV pattern generator; a CMOS digital frequency counter, and an electronics Discovery Lab. This gives you both TV and Audio training for hundreds of dollars less than the tuition cost of TV and Audio combined from the next leading school.

This Master Course combines theory with practice, using the "Power-On" stages for experimentation and learning. Building NRI's equipment will give you the confidence and ability to service any color TV or Audio unit on the market. And you'll have a magnificent TV and quadraphonic system for years of trouble-free performance.

Advanced Pro Color with 19″ diagonal color TV...$665 or low monthly terms

An advanced Color TV Servicing Course for experienced technicians, 18 lessons, 5 new "Shop Manuals", and NRI 19″ diagonal Color TV receiver with cabinet.

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No man knows the rewards of owning the best like the man who rides the Deere.

A John Deere Lawn and Garden Tractor is an investment that'll pay dividends for years to come. It's available with 10-, 12-, or 14-hp engine. And its 4-speed transmission has a variable-speed drive that lets you change travel speed without clutching or shifting. Or without reducing the working speed of the mower or tiller attached. And because it's a John Deere Lawn and Garden Tractor, it's "human engineered."

Controls are clustered, within easy reach; color-coded for quick identification. The seat is cushioned, and high-backed for support.

The operator's platform is wide and roomy. A triple-safe starting system prevents accidental starts when the mower is engaged, or the transmission is in gear. And besides mowers, we can provide a dozen other John Deere attachments matched to the tractor size. So you have a versatile workhorse that pays you back in time and work saved year after year.

In our business, that's a green chip.

JOHN DEERE

Nothing Runs Like a Deere®

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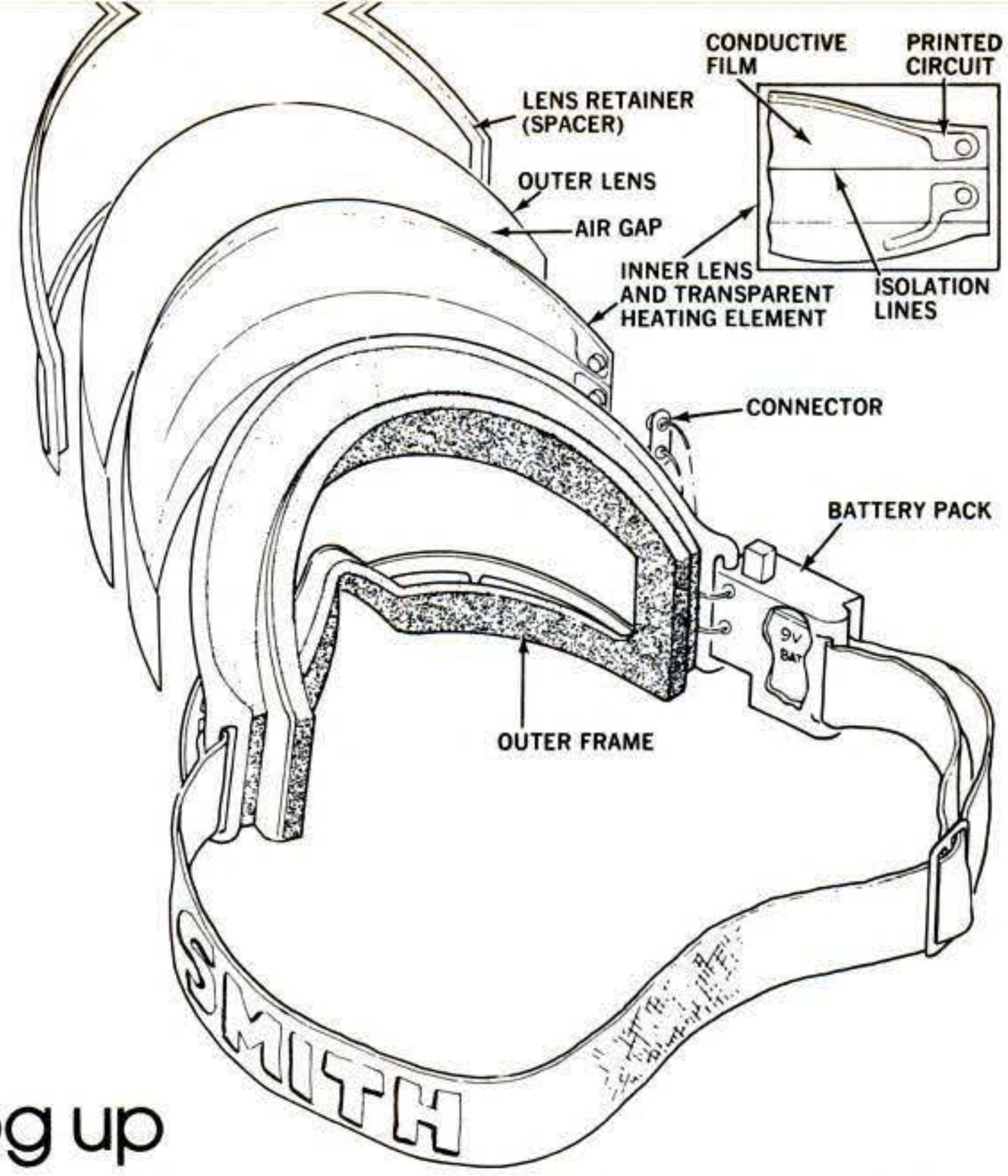


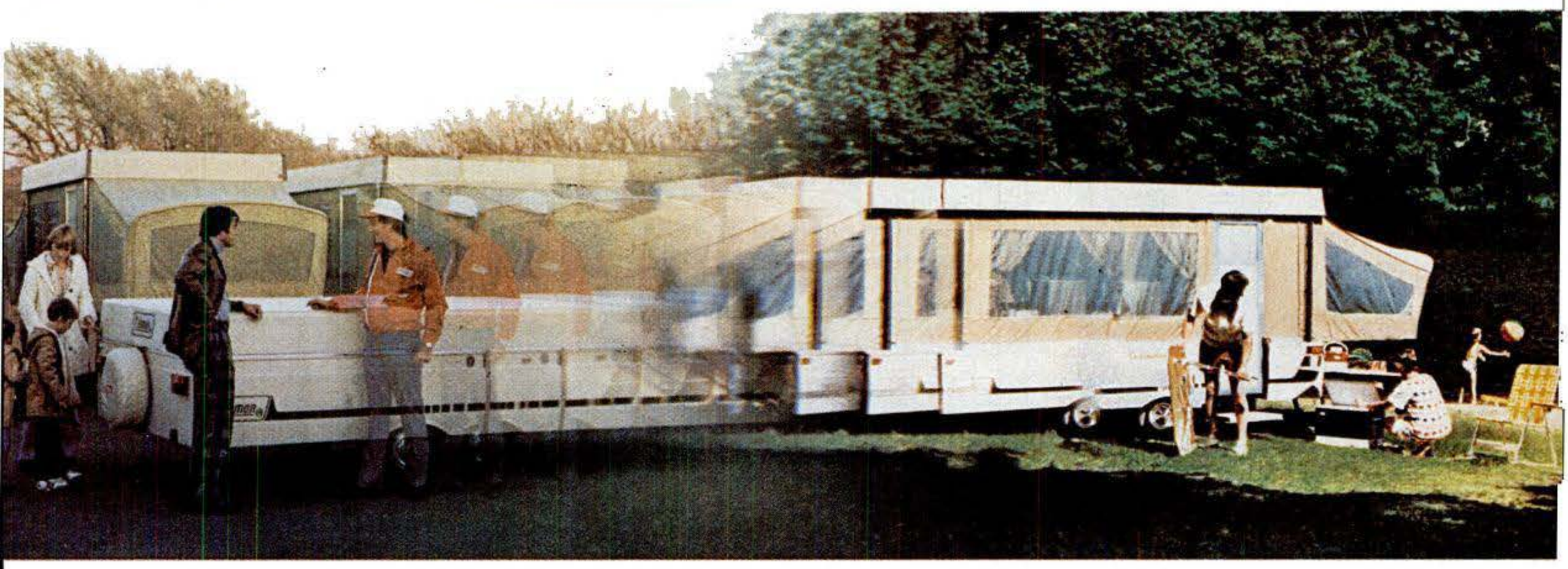
Heated goggles don't fog up

Now space-age technology has come to the aid of skiers: An electrically heated transparent film, similar to the material that kept the Apollo astronauts' faceplates fog-free, keeps these new ski goggles crystal-clear for the downhill set.

A thin metallic film deposited on the transparent inner lens (see drawing) is the conductor. A nine-volt battery provides the juice.

The goggles will be made by Sierracin Corp. of Los Angeles, maker of the metallic film; and the Smith Goggle Co. of Sun Valley.

Price? Says Sierracin's product manager, Bruce Campbell: "We are hoping to bring this product to market for under $30, and under $40 for a rechargeable version."—*R. L. Stepler*



Buy your Coleman Camper now...we'll make your payments 'til spring.

Buy any Coleman 1977 camping trailer between January 1 and March 31, 1977, and we'll make all your payments 'til spring! That means you can save up to $150—and the earlier you buy, the more payments we'll make for you.

See your Coleman Camping Trailer dealer's seven new 1977 models. They range from a compact trailer for small-car towing clear up to larger luxury models. Each is designed to give your family the fun, carefree feeling of the great outdoors—while you still enjoy complete at-home comfort!

Choose the Coleman camping trailer that best fits your family and your budget. Buy it now. And we'll make your payments 'til spring!

Buy this Coleman Camping Trailer	We'll pay up to this much!
Brandywine	$150
Lexington	150
Yorktown	150
Saratoga	140
Valley Forge	130
Concord	130
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Camping Trailers
the camper's camper

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Somerset, PA. 15501

Write for free full-color literature!

Limited-time offer. Based on standard 36-month financing with 10% down payment and 12.5% interest rates. Offer good in Continental U.S.A. only.

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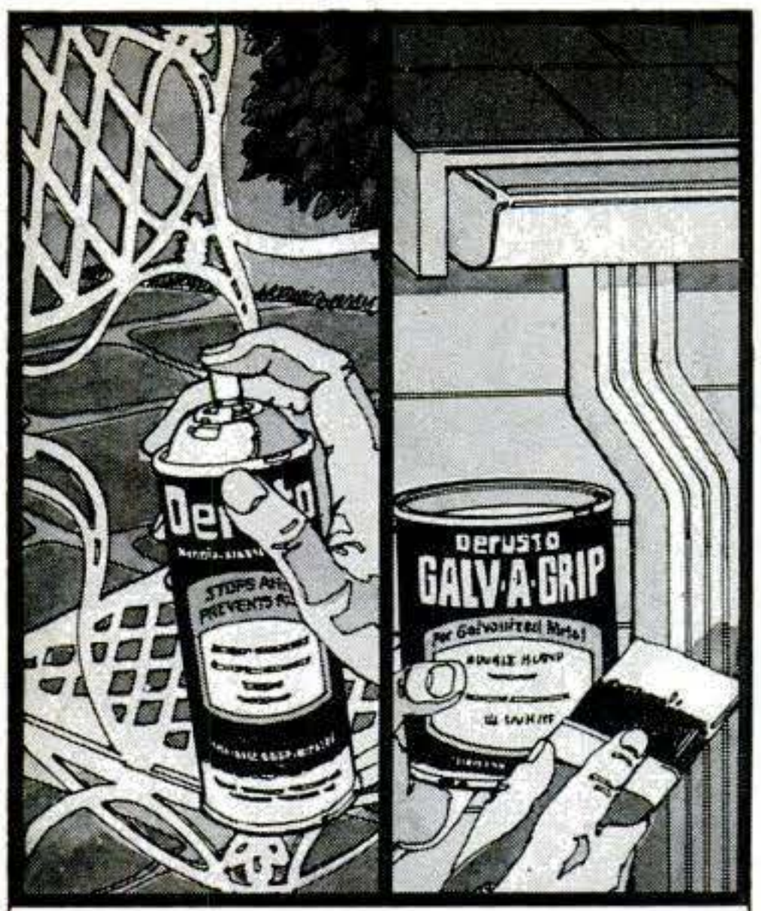

One coat primes and protects against rust.

Derusto Minute Finish Spray has a special rust-inhibitive primer built into every attractive gloss color for one-step rust prevention. Contains no fluorocarbons. Makes rusted lawn furniture, bikes, and mowers look like new. And stay that way.

Derusto Galv-A-Grip™ primes and protects all galvanized metal in one coat. Won't check, crack or peel like ordinary paints, so it's ideal for use on gutters and downspouts. Dries in 3 to 4 hours.

Home paint-up's a snap with Derusto® by DAP

DAP Inc., General Offices: Dayton, Ohio 45401
Subsidiary of Plough, Inc.

"SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Oil-burning problem

I have a '73 Ford pickup with a 360-cu.-in. engine that has started using oil at a rate of about a quart every 200-300 miles. It has never gotten hot, and it smokes only when it has been idling for a few minutes. It has 40,000 miles on it. The tail pipe is burning clean and the car is not leaking the oil. I also have a '73 Grand Prix 455 with 40,000 miles that has this problem, although it's not quite as bad; and it never smokes.

Bobby Moore, Temple, Tex.

First, check crankcase venting and pressure to make sure it's normal. This can affect oil consumption strongly. Next, get to a Sun cylinder leakage tester. Blow the engine down and check the percent of leakage. It sounds like the rings are worn on both engines. Readings of over 12-percent leakage mean trouble. The leakage test won't really give you an answer on oil rings; but oil-burning engines usually have a worn or stuck compression ring as well.

For oil trouble, 40,000 miles is early, so I'm wondering if your air filters are doing their job. Also, have you changed oil and filter often enough?

If rings check out, you could have a valve-stem seal problem. Also—this is way out, but it sometimes happens—the cam drive gets worn and the cam runs late. Oil consumption can rise in this situation.

If you have to pull the engines down, and you find rings stuck and a lot of residue, look over the oils your supplier has and see if you were in best specs.

About the Vega engine

It is my understanding the Pontiac Astre for 1975 and 1976 is essentially the Chevrolet Vega, which uses the cast-aluminum block with a cast-iron head. The quality and life of this engine in which the cylinder bores are machined directly in the cast aluminum has apparently been the subject of much controversy and misunderstanding.

A Pontiac sales brochure shows that the Astre for 1977 is available with either the 140-CID aluminum engine or a 151-CID cast-iron engine. I would like to know whether this Pontiac 151-CID cast-iron engine is interchangeable with the aluminum engine in my 1974 Vega. If such an interchange is feasible, how complicated would the change be? The car has the three-speed automatic transmission, factory air, manual steering and manual brakes. I would want to retain these.

Also, is a loud "rapping" noise common in the Vega engine? The dealer service manager told me repeatedly (while the car was under warranty) that this is characteristic of the engine! However, at 25,000 miles they told me the valves were excessively noisy and needed adjustment—that is, until I told them the valves had been operating with tappet clearances of .022 to .024 on exhaust and .012 to .014 on intake for the past 20,000 miles. Then they said there must be something else wrong with the valve gear.

One more thing. Why is the engine slow-starting when warm? The dry setting of the float in the carburetor bowl is at specs; so is the automatic choke setting and operation. But this slow starting has persisted since the car was new. The district service representative tells me I could not expect a four-cylinder engine to fire up instantly like a V8.

William K. Body, Albany, Ore.

Your questions are asked by many. As a rule, I'm opposed to engine changing, because of cost and unforeseen problems. But it may just be the Pontiac iron four-cylinder might be pretty easy to get into a Vega. I wouldn't be surprised to see that being offered as a flat-price kit by some of the specialties garages.

Vega's current four-cylinder is not going to make it to the Hall of Fame. Pontiac's iron four-cylinder seems to be a solid design. But maybe you ought to watch it awhile. As far as the loud rapping being standard equipment, I don't believe anyone could sell me that program. Slow starting when hot is a disease coming from emissions controls.

Should you mix oil brands?

Self-serving advertising aside, is there really any reason for not alternating use of different brands of top quality oil at oil changes? In adding oil between changes? Many of us do-it-yourselfers would like to buy on the basis of special sale prices rather than stick to one brand. I am thinking, of course, of comparable-quality oils such as Pennzoil, Quaker State, Havoline, Chevron, etc.

E.L. Stickel, Federal Way, Wash.

The code of the hills is all oils are compatible with each other. Generally speaking, this is true, but I have seen much severe damage when two major oils got together and something went wrong chemically and the oil turned to jelly.

Engine manufacturers keep changing recommended oil specs, as does the military. Since even the experts change their advice and confuse the issue, how can the average motorist keep track of

Continued

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200-SX

Suddenly from Datsun: A sporty car with everything but a sports car price.

Exit dull, sluggish economy cars.

Enter Datsun's spicy 200-SX. Sweet-handling. Tasty appointments. And no bitter price to swallow.

Enjoy.

Fun and frugal 5-speed.

Sporty 5-speed transmission works like overdrive. So it not only zips around traffic, it saves wear and tear on the engine. About the engine: it's the 2-liter single overhead cam type. The type sports cars are made of. All of which makes the 200-SX anything but dull.

Extras, yes. Extra cost, no.

- AM/FM multiplex stereo radio
- Steel belted radial tires
- Tachometer
- Fully reclining bucket seats
- Cut-pile carpeting
- Electric rear window defogger
- Tinted glass
- Electric clock
- Sporty 5-speed gearbox
- Power-assist front disc brakes

All for under $4500. (Manufacturer's Suggested Retail Price not including destination charges, taxes, license or title fees and optional tape stripe and mag-type wheel cover package.)

Tough sport.

Solid, all-steel unibody is but one example of how the Datsun 200-SX is put together to stay together. Fact is, when we made this fun little car, we made sure of one thing.

The fun would last.

Suddenly it's going to dawn on you.

DATSUN SAVES

all this? My advice is to pick an oil you have confidence in and that meets manufacturers' specifications, and don't risk a chemical backfire. My stand is not that if you mix oils you will have a failure. Actually, I'm just trying to get a little further away from Murphy's Law.

Oil change without oil

I have a 1976 Chevy C-10 pickup with a 350 V8 four-barrel and standard transmission. At 8900 miles I took it to the dealer to have the oil changed. The problem is that he didn't put any oil back in. As near as I can figure the engine was operated eight or ten minutes without oil. It was driven from the garage to be parked, and then from parking to the highway before I caught the problem. I raced the engine a couple of times before I shut it off in an attempt to raise oil pressure. The engine appears to be running fine now, and I was assured that there was no engine damage. The dealer said that he replaced the rod and main bearings, and I had an independent mechanic look at some of the bearings that came out. He said they didn't appear to be damaged.

Afterwards I checked the oil and discovered they added an *extra* quart. It's since been used up. The dealer claims that Chevy says the engine operates at 245 degrees and it's not uncommon to expect this car to use a quart per thousand miles.

Was the engine really damaged? How can I tell? Was engine life reduced? What can I do?

Ron Zwald, Clarksville, Ind.

Your deal is a can of worms. It's hard for a garage to decide to pay for an internal exam. But anything other than disassembly and inspection is an educated guess. I've been in the same fix with a much more expensive engine. We pulled the pan and bearings. They looked okay. But the owner still was nervous, so we went all the way. Good thing we did—the cylinder bores were damaged.

Seven or eight minutes without oil pressure is quite long. A quart of oil per 1000 miles is not normal. Most will only use a quart in 4000-5000 miles. In severe service they will use more but not that much. Main thing is, how does your oil consumption now compare with it before the problem?

What can you do? Go back to the service department. Be reasonable, but ask for whatever it takes to satisfy your concern.

Brake problem

Each morning when I press the brake pedal in my Datsun pickup, it goes slowly to the floor. After several pumps I have good brakes all day, even after parking eight hours at work. But after parking all night, the pedal goes to the floor. What's wrong?

J. W. Smith, Alameda, Calif.

Three main things are involved:

1. Brake shoes should be properly adjusted—within 0.010 of the drum all the way around.

2. The system must be free of air. Air in a system will cause a problem, and sometimes requires much careful light-pressure bleeding.

3. The master cylinder must work properly. If fluid bleeds back into the master cylinder because of lack of residual pressure control, this could cause the problem you describe. Or, it could be caused by incorrect adjustment of the master cylinder in reference to piston and fluid supply intake.

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

The knife is still around

(even if the girl isn't).

First knives, like first loves, are something you don't forget.

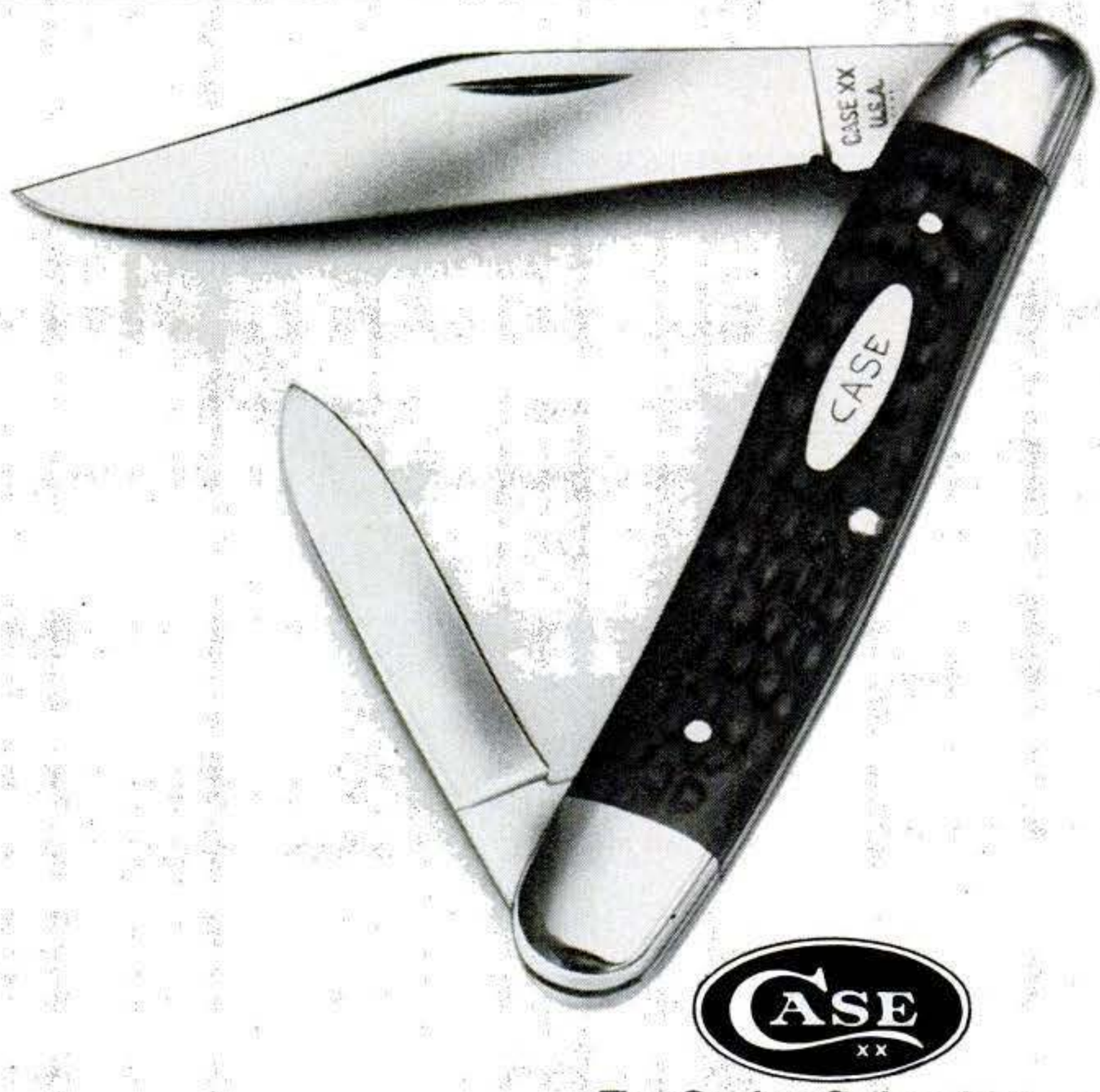
For over a hundred years, we've made Case pocket knives with the same care and attention to detail.

Today there are still some 150 skilled hand operations in every single Case knife. So they're just as tough and reliable as that pocket knife you had as a kid.

More than a 100 to choose from. In a variety of sizes and combinations.

You may not feel the same way about the girl, but Case wants you to feel the same way about the knife.

See them at hardware and sporting goods stores.



CASE XX

The Quality Cutlery Makers

W. R. Case & Sons Cutlery Co., Bradford, Pa. 16701.

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Americans have been using Motorola 2-way radios to find campsites for years.

It's a fact that the people who first put radio on wheels also made the first radio on wheels on the moon.

But it's not surprising.

Because Motorola® makes more radios for police, firemen, taxis, and lunar rovers than anybody.

And now Motorola makes a 40-Channel CB radio that shares much more than a name with our professional 2-way radios.

The clean, uncluttered lines of the Motorola CB, for instance.

Features that many manufacturers leave on the outside of their sets (or don't offer at all) are built into a Motorola CB.

Gain control, noise limiting, audio compression, even a TV interference filter are built-in, fully automatic circuits that actually make communication better.

And operation easier.

A digital phase lock loop synthesizer provides precise tuning (automatically, of course).

A professional-quality 3½-inch top-fire speaker gives the Motorola CB an audio quality that must be heard to be fully appreciated.

And every Motorola CB gives you the added advantage of a power mic that doesn't need batteries. That doesn't cost 50 bucks extra.

The Motorola 40-Channel CB radio.

We believe it's the most sensibly engineered CB radio on the market. We believe it will deliver years of service at a level of performance few could match.

Put a Motorola CB radio under your dash and you'll believe, too.

Motorola CB

From the voice of experience in 2-way radio.

To find the dealer nearest you, write: Customer Relations Manager, Motorola, Inc., Automotive Products Division, 333 Northwest Ave., Northlake, Illinois 60164.

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© 1977 R. J. Reynolds Tobacco Co.

I can't taste numbers. I can taste Winston Lights.

I was looking for a cigarette with low tar. But the low tar cigarettes I tried had no taste. Now I smoke Winston Lights. I get the low tar I want. But more important, Winston Lights are all taste. Winston Lights are for real.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

13 mg. "tar", 0.9 mg. nicotine av. per cigarette, FTC Report DEC. '76.

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Popular Science

PS | What's News

Fresh new ideas in light-plane design are hard to find. Most that we hear about turn out to be based on concepts that were in the textbooks before World War II. The reciprocating-piston engine and conventional prop, to which most are wedded, seriously limit possible innovations. When a new idea is brewing, though, we can count on Ben Kocivar, our Flying editor, to be among the first reporters to wangle a chance to fly just about anything that will become airborne. He was among a group of about 20 journalists who were flown from London to West Germany to view the Fanliner. But Ben wasn't satisfied with just seeing it. He quietly made a date to come back the following day and fly the prototype. Leaving London at 2 p.m., he flew commercial to Düsseldorf, drove a half hour to the airport where the Fanliner was berthed, flew the plane, got his interviews and was back in London by 7:45 p.m. the same day. To find out what Ben learned in that short period, see his story beginning on page 87.

Coal-conversion funding

The coal-gasification program [PS, Jan. '77] has recently received new impetus. The Energy Research and Development Administration (ERDA) and the American Gas Association (AGA) have signed an agreement to continue a joint effort begun in 1971. Under the agreement, which will last through June 1979, ERDA will put up $20 million per year and AGA will contribute $10 million annually for the construction and continued operation of coal-to-gas pilot plants. To date, $150 million has been pumped into the program, under which four pilot plants have been built. Two are in Chicago: One makes synthetic natural gas, the other will make hydrogen from the char byproduct of the first plant. The other two plants are in Rapid City, S.D. and Homer, Pa. ERDA is expected soon to award contracts for the design of large demonstration coal-gasification plants, which should lead industry to commercial coal conversion.

Solar-power-tower site

This country's first solar-power-tower electric-generating plant [PS, Oct. '75] will be built in the Mojave Desert near Barstow, Calif., according to a recent announcement by an official at ERDA. It will be a pilot project with an electric generating capacity of 10 megawatts. Work on the $100-million installation is scheduled to start in 1978. A group of utility companies headed by Southern California Edison offered the 103-acre site finally selected from among nine sites originally proposed by various groups. The California team will provide conventional steam-turbine generating equipment and an electrical-distribution network.

Meanwhile, work is progressing on schedule on the thermal-only solar-power-tower project being built at Sandia Laboratories in Albuquerque, N.M. This facility will only test the concept of generating high-temperature steam—there will be no electric power generated. They intend to be operating at a one-megawatt level in April and reach the full five-megawatt capability by December. Lessons learned here will be valuable in the final design and setup of the Barstow plant.

Solar heating competitive

Solar home heating can now compete in cost with electric baseboard heating for well-insulated new homes in major population centers throughout most of the U.S. And, if the cost of solar heating drops another 25 percent, it would be competitive with oil or heat pumps in many areas. These are conclusions made by a new study prepared by Mitre Corp. for ERDA. In the study, a solar system is considered to be economically justified if annual fuel savings exceed annual payments of principal and interest on the cost of the system within five years, or if the system pays for itself by lowered fuel costs within 15 years.

"Our goal," said Dr. Henry Marvin, director of ERDA's Division of Solar Energy, "is a 50-percent reduction in the cost of solar installations by 1980 through market competition, improved performance, reduced cost of equipment and installation, and possibly incentives." Data in the study assume that an installed solar system today costs about $20 per square foot of flat-plate collector used. Optimum collector sizes generally range from 20 to 30 percent of the square footage of the house, depending on local conditions. Systems are on the market now at both lower and higher prices than $20 per square foot and with different levels of performance. The study chose a representative cost and performance. The Mitre report will be published soon. You can get further information on solar heating, including the price and instructions for ordering this report, by writing to the National Solar Heating and Cooling Information Center, P.O. Box 1607, Rockville, Md. 20850.

Ground-water recharge

A unique project to recharge the ground-water supply on Long Island has gotten a $24.6-million grant from EPA. To help solve a water-supply crisis [PS, April '74] looming in an area entirely dependent on ground water for drinking water, Nassau County has been given the go-ahead to accept bids for construction of a 5.5-million-gallon-per-day, full-scale waste-water-recharge demonstration project. Reclaimed water from Nassau County Sewer District No. 3, after treatment to meet drinking-water standards, will be pumped through a 24-inch pipe to recharge basins and injection wells at East Meadow. Returning wastewater to the ground, it is hoped, will slow or stop the gradual depletion of the ground water, which has caused officials to project a water deficiency of 92-million gallons a day by 1990 if nothing is done.

Fusion advance

The first production of a billion fusion reactions in a laser-fusion experiment [PS, Dec. '76] has been achieved by University of California researchers at the Lawrence Livermore Laboratory. Early laser-fusion experiments in 1974 produced about 10,000 reactions. In 1975, the number reached 50 million. To demonstrate feasibility of laser fusion as a power source, future experiments will have to provide about a billion billion fusion reactions.

Hubert P. Luckett

Editor-in-Chief

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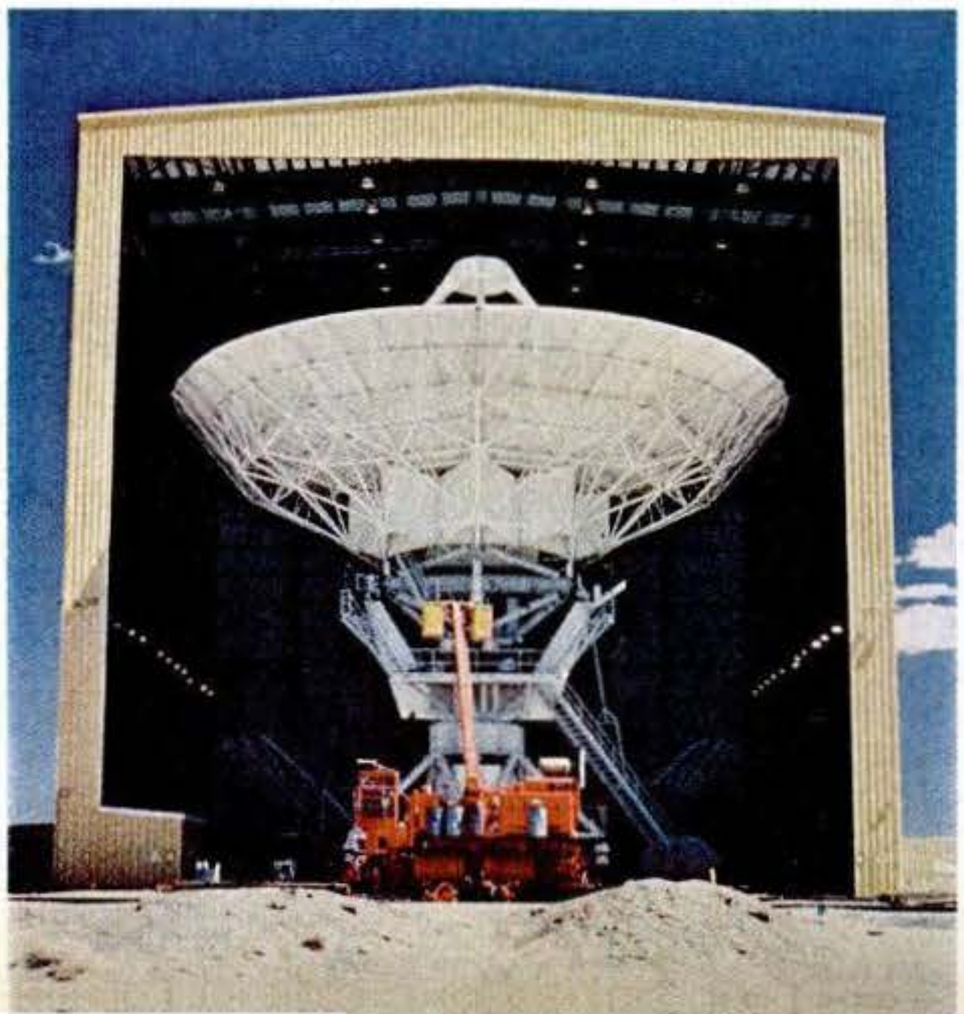
27 movable dishes:

World's largest radio telescope

Deep-space ears: Giant antennas stand ranked on concrete observing stations (above). A newly completed antenna waits inside maintenance building (near right) for the rail transporter to move it out. Engineers adjust transporter's wheels (far right) during moving operation, as antenna's huge base-frame juts out over their heads. Movable antennas will give astronomers the equivalent of a single, gigantic, fully steerable dish.



Stretching out 17 miles, VLA will peer out to the edge of cosmological time

By RAY NELSON

PLAINS OF SAN AUGUSTIN, N.M.

Speeding west on U.S. Highway 60 in New Mexico, I knew what to expect, but it still came as a jolt. This is an area of wind, dust, and silence, bordered by the solemn peaks of the Continental Divide—and almost uninhabited. After passing through the sleepy town of Magdalena, I'd seen nothing living except a few grazing cattle and some startled antelope. Suddenly, shimmering before me in the mirage-heat of the Plains of San Augustin, I spotted a row of colossal, dish-shaped antennas, gleaming white against the indigo sky, alongside a railroad to nowhere.

I had arrived at the site of the largest radio telescope in the world —the Very Large Array (VLA). This enormous complex, 75 miles southwest of Albuquerque, is being built by the National Radio Astronomy Observatory (NRAO, which is operated by Associated Universities, Inc., for the National Science Foundation).

When completed in 1981, the VLA will be a sprawling layout of 27 huge antennas arrayed along three railway arms laid out in a gigantic Y shape. Each 94-foot-tall antenna weighs 211 tons, has a dish diameter of 82 feet—and is fully portable. The giant dishes can be carted by self-propelled railway transporters to any one of the 72 concrete observing platforms set alongside the track. Within a day, the antennas can be clustered together at the heart of the Y, or stretched out along the 13-mile arms of each segment. This flexibility gives radio astronomers the equiva-

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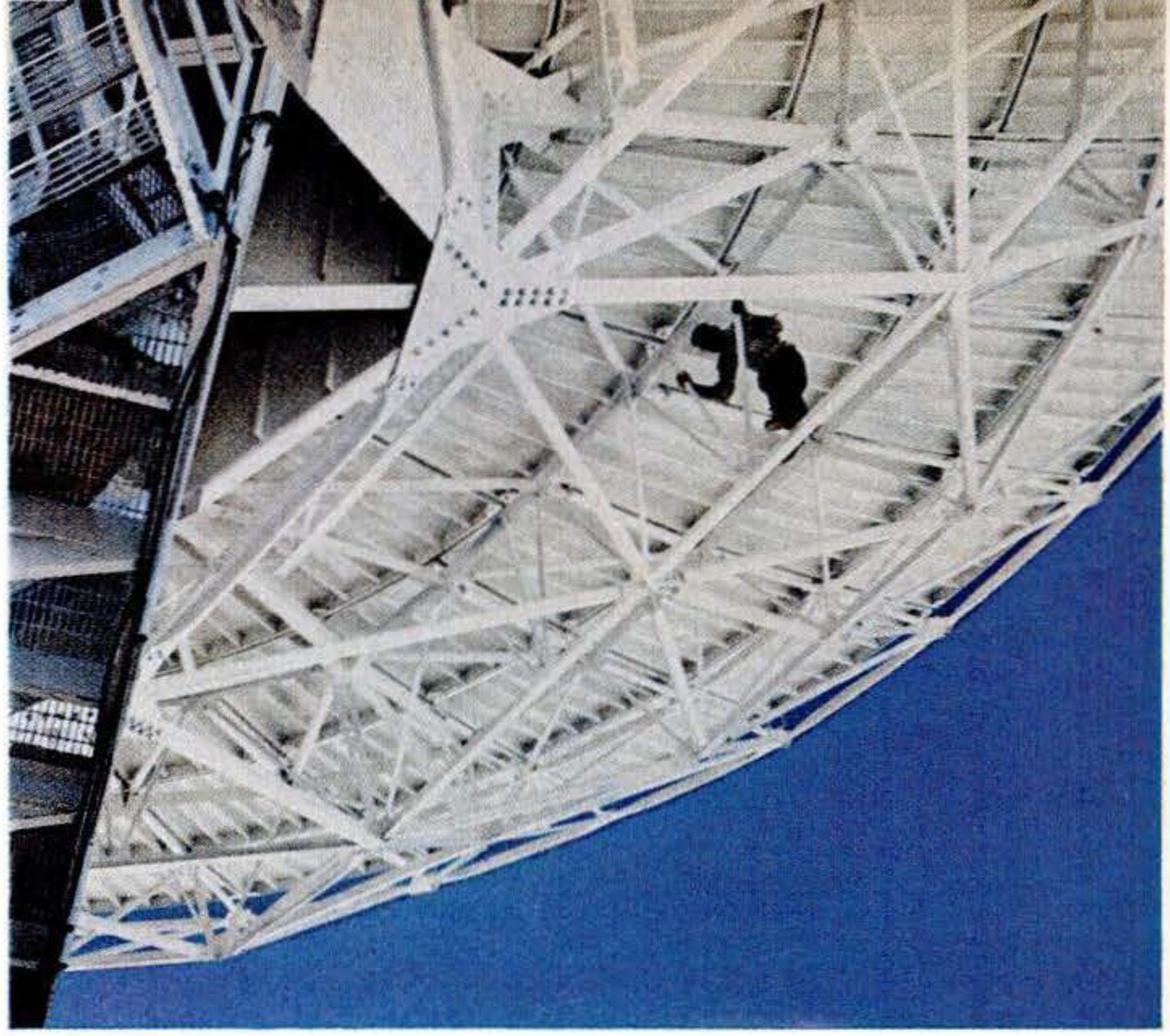

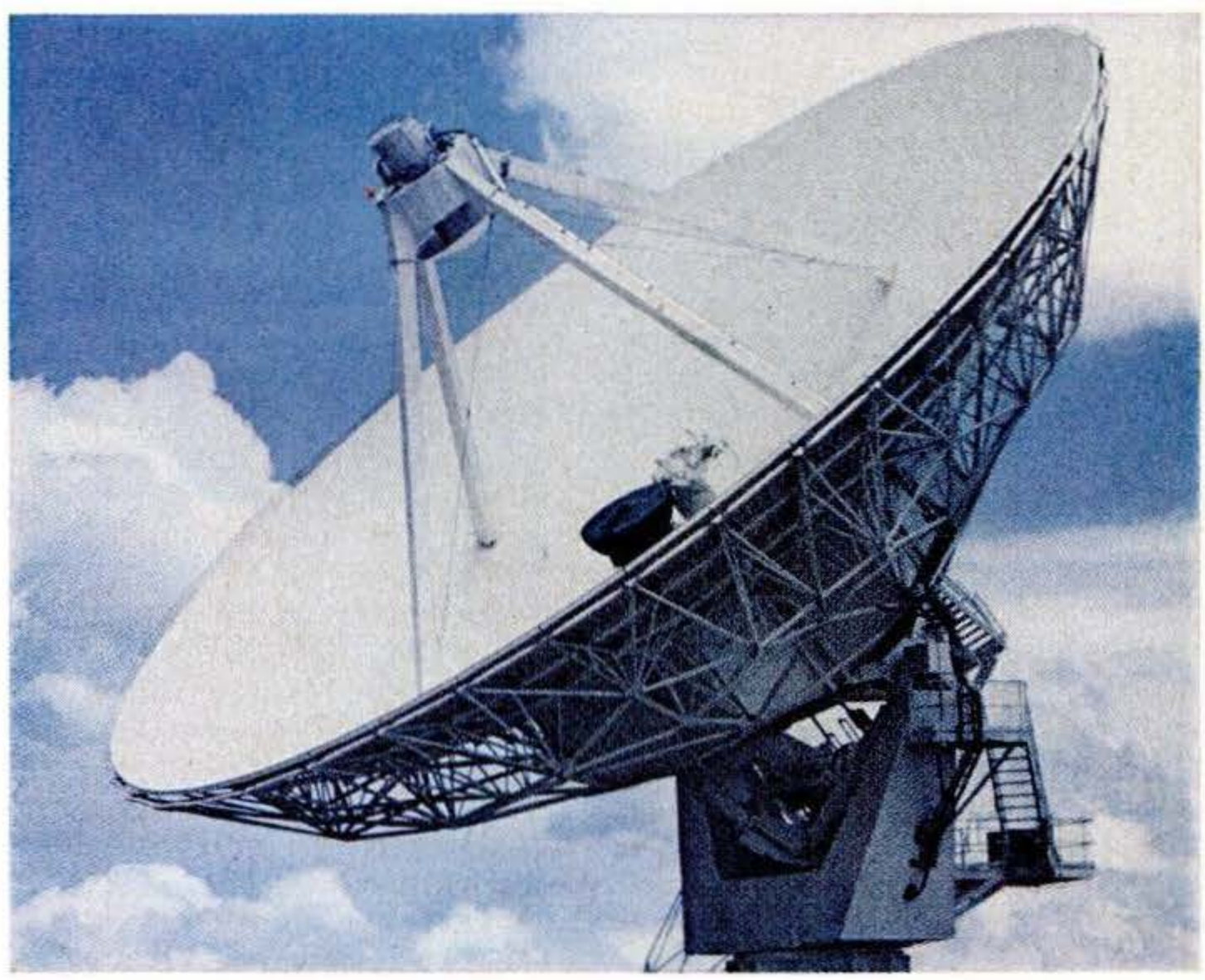

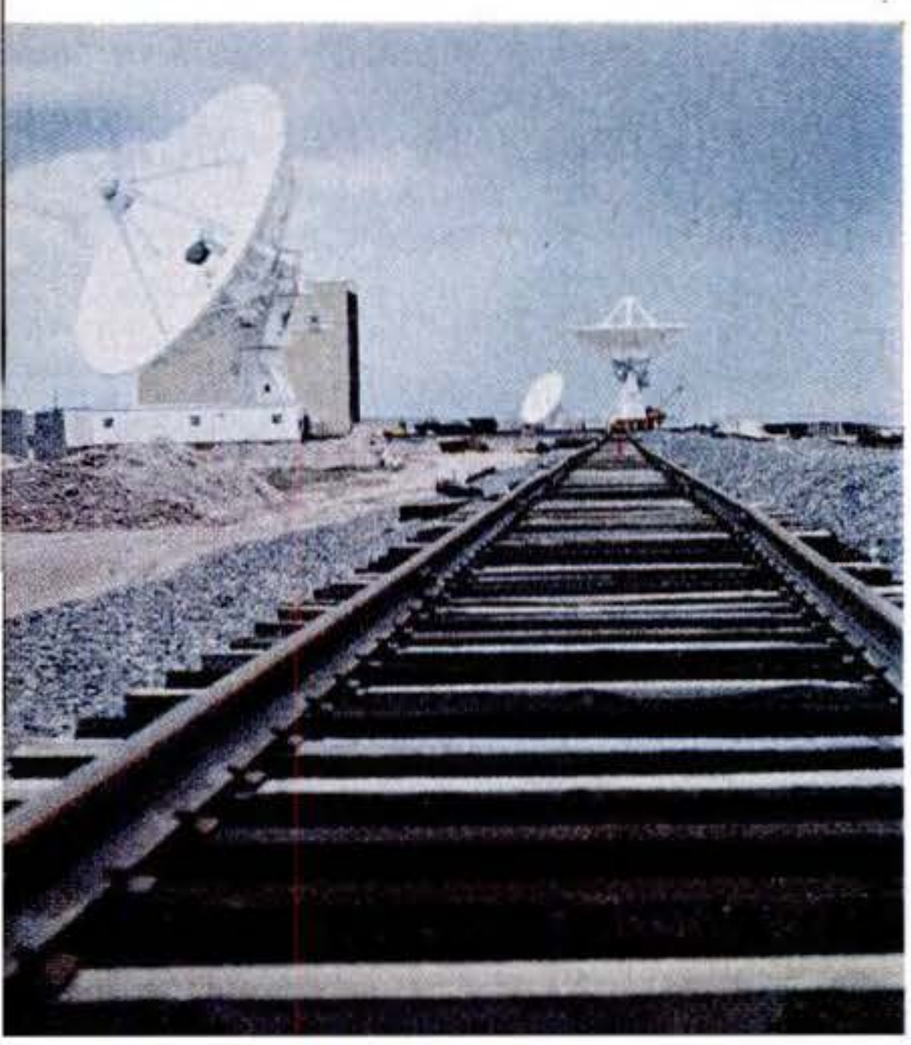

Dwarfed by a maze of girders, an engineer inspects a dish's underside (top photo). The antenna points skyward (above), ready to track stars. Four tubes support the Cassegrain subreflector, which bounces radio waves from main dish back down to feed system on its surface. The 65-ton transporter (near left) shuttles an antenna to its station on the "railway to nowhere" (far left). By 1981, 27 dishes will be arrayed along the rails.

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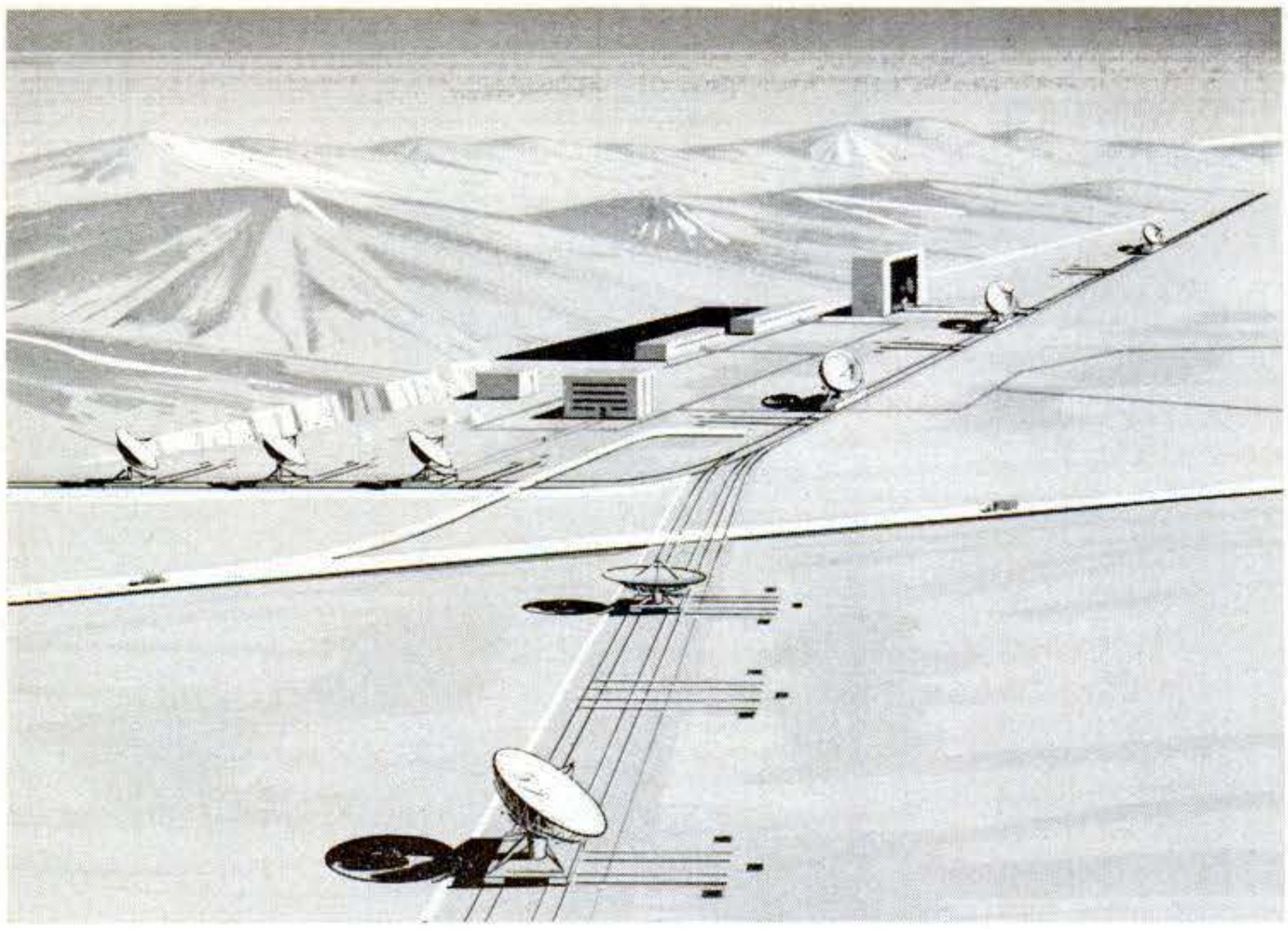

Antennas sit on the tracks, waiting for positioning on observation spurs. The computer center and the antenna-assembly building are in headquarters complex.

lent of one fully steerable dish antenna about 17 miles in diameter.

With the building of the immense 1000-foot dish in the Puerto Rican hills at Arecibo [PS, July '75], the single-dish antenna reached its maximum practical limit. Now radio astronomers are turning to the array concept—the use of many antennas to produce results comparable to those from a single massive dish. Smaller arrays have been operating for the past few years—a three-element one at Greenbank, W. Va.; Cambridge, England's six-element array; and today's most powerful radio telescope, the 12-element array at Westerbork, Netherlands. But radio astronomers wanted a still larger array—one that would give them up to a hundred times the power of existing radio observatories.

Probing the universe

The VLA will answer this need. According to NRAO, it will be the premier instrument for radio astronomers seeking to answer a wide range of questions about the nature and extent of our universe.

"It's the next logical step in deep-space research," said Dr. Barry Clark, glancing out his office window at the big white antennas lined up neatly on their concrete foundations. "We're looking farther into the extreme reaches of the universe than ever before, and we need to know more about what we're seeing. The signals are weak because of the great distances—so we need bigger radio telescopes, ones that are more sensitive and can provide better resolution than the antennas that we have at the present time."

What specific research problems would radio astronomers tackle with the VLA's massed antennas? "The quasars, for example," Dr. Clark said. "If you condensed all the stars in our galaxy into a single body roughly the size of our solar system, you might have something resembling a quasar, but we still don't know what they are. They're powerful sources of energy, but they're so distant that to us they appear faint and weak. The nearest quasars," he added, "are two *billion* light years away—but we've got to learn all we can about them because they can tell us a lot about our universe."

If we can locate enough quasars and measure the rate at which they are speeding away from us toward the edge of the universe, said Dr. Clark, then we may be able to answer a key question: Will the expanding universe reach escape velocity and rush forever off into the void? Or will it fall back into itself, creating another "big bang"?

Dr. Clark lists some other areas where the VLA will help astronomers grapple with unanswered questions:

- *Pulsars.* These are believed to be burnt-out stars that have collapsed into small (five to 10 miles in diameter), superdense balls of neutrons. Their rapid rotation generates uncannily regular radio pulses every second or so [PS, June '69]. Through expanded radio research, astronomers hope to solve the puzzle of why some pulsars' rates of rotation, which gradually slow over the centuries, occasionally speed up before slowing down again. Astronomers theorize that the pulsars still have some internal activity going on and that the resultant "starquakes" cause them to become even more dense, and thus to spin faster. But more data is needed to be certain.
- *Interstellar molecules.* Radio emissions from about 40 kinds of molecules have already been detected in the distant clouds of gas and dust on the edges of the Milky Way. The VLA will probe for evidence of more organic molecules in these clouds, which some astronomers believe are the breeding grounds for stars and planets. The big question: Are planets born ready-stocked with the "stuff of life"?
- *Radio galaxies.* These are dim in the visual wavelengths of the spectrum, so optical astronomers cannot get at them easily. But they are strong emitters of radio waves, and the VLA should be able to map them in detail.

Resolution and radio signals

These probes into deep space will be made possible by the VLA's superb resolution. Resolution, the ability to distinguish fine details, has been one of the weak points of radio telescopes. Until recently, they could not even match the resolving power of the unaided human eye—which can separate two points of light about 180 seconds of an arc apart. (Resolution is measured by calculating the arc of angular separation between two points.) By contrast, the 200-inch optical telescope at Mount Palomar has a resolution of 0.0225 seconds. The VLA, with a resolution of up to 0.13 seconds, will achieve results comparable to those obtained by the best optical telescopes—and this is what radio astronomers are most excited about.

The VLA's superior resolution is achieved by a technique called interferometry. Whenever a radio signal from one source arrives at two different antennas, interesting things happen. If the signals arrive at the two telescopes in phase, they reinforce each other. If they arrive out of step, they cancel each other. The resulting interference pattern shows periods of reinforcement or cancelling, called fringes. By studying the fringes, astronomers can accurately pinpoint the object's location.

With the different pairings possible among the VLA's 27 antennas, up to 351 sets of interferometers can work at tracking a star across the sky.

Good sky coverage was one of the

[Continued on page 170]

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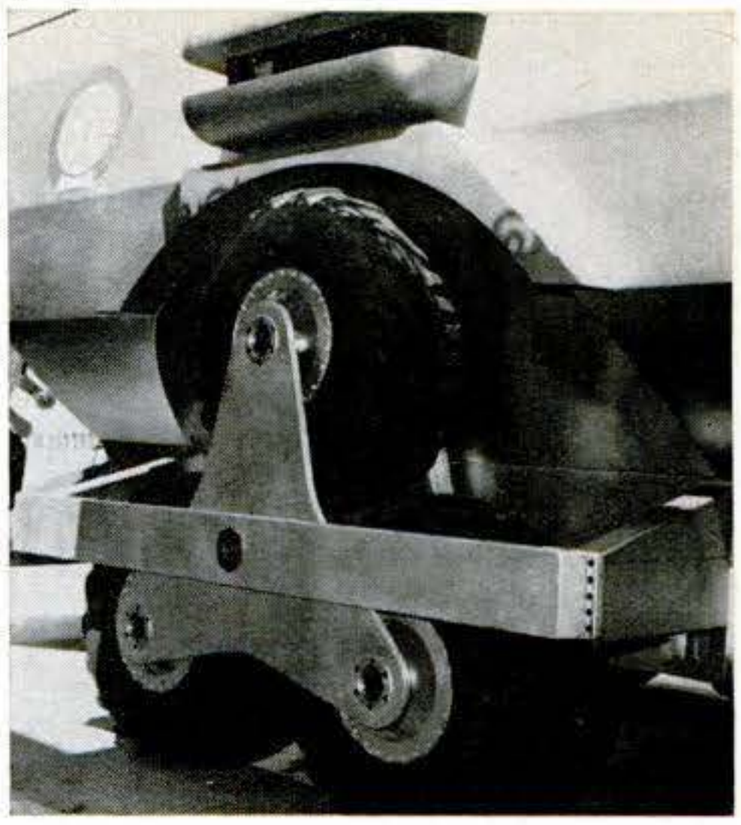
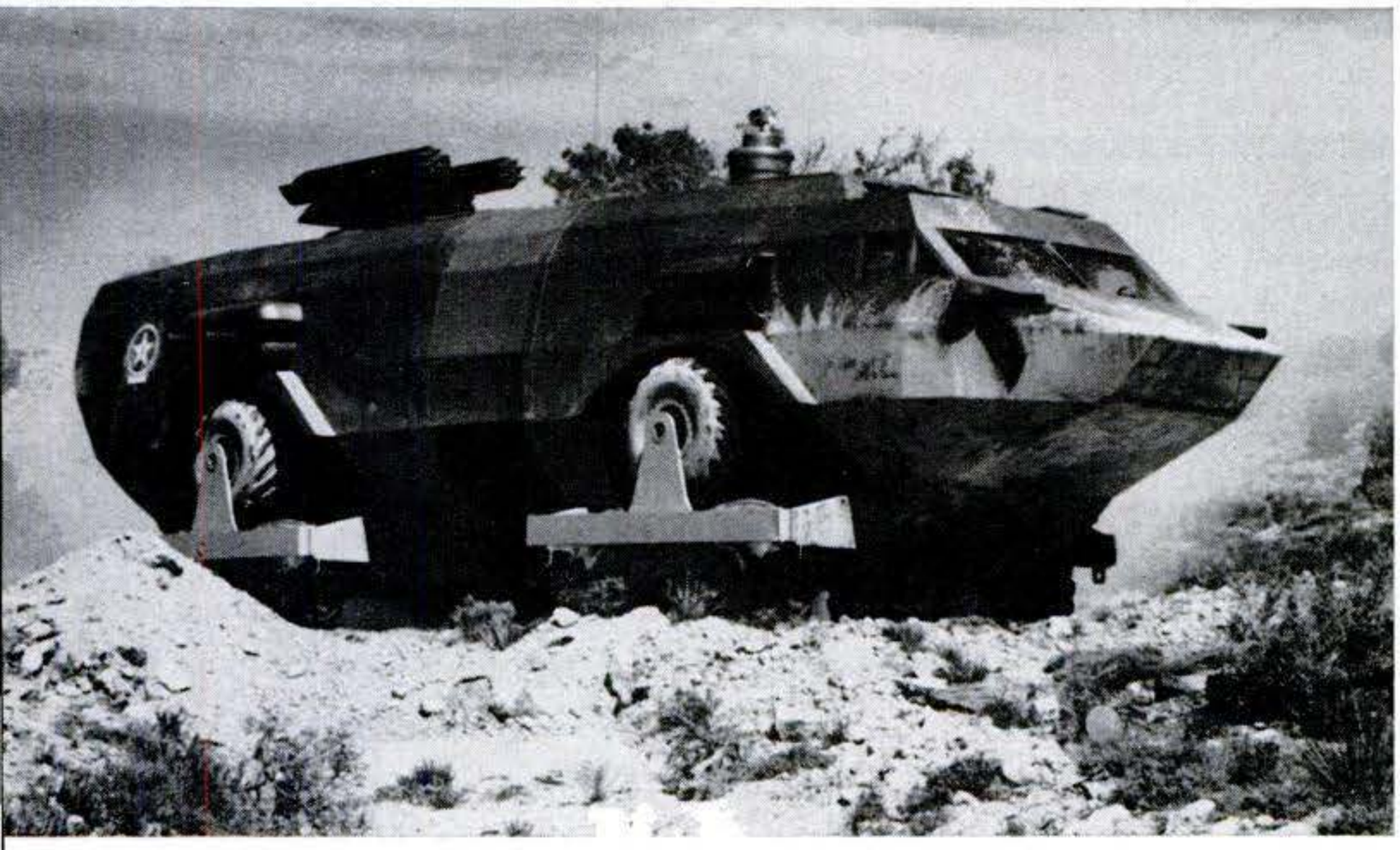
Monster vehicle
to star in movie





Triangular arrangements of Land Master's 12 wheels make it maneuverable in the toughest terrain. Twin bazookas sit atop the vehicle; cannons project from its sides. Shown disembarking from the two-ton structure (35 ft. long, 10 ft. 7 in. wide, 11 ft. 10½ in. high) are Dominique Sanda, Jan-Michael Vincent, and Paul Winfield.

By JACK SCAGNETTI

One of the largest and most ingenious vehicles ever built to perform in a motion picture will play a leading role in the sci-fi thriller "Damnation Alley," a Twentieth Century-Fox film.

The Land Master, an 11-ton, 35-foot-long military machine, is used to transport survivors of a nuclear war eastward from Arizona in search of other humans. In an attempt to reach the East Coast, where they think some remnants of civilization may exist, they battle a continent ravaged by the holocaust and bombarded by freak weather conditions in which only a special all-terrain vehicle such as the Land Master can maneuver.

The Land Master was built by Dean Jeffries of Studio City, Calif., based on the patented invention of Robert W. Forsyth and John P. Forsyth, of the Vehicle Development Corp. Its most outstanding feature is a system of 12 wheels arranged in triangular sets that enable the machine to run easily through sand, mud, and water. The triangular wheel assembly, gear-driven at all times, operates with two wheels on the ground and one above. If the Land Master hits a rock or a hole, the top wheel rotates into position to force the Land Master over or through the obstacle. Highly maneuverable, the vehicle can turn at 30 degrees and make a complete circle in 35 feet. Farm-equipment tires, 38 inches in diameter and 24 inches wide, are mounted on special 16.1-inch wheels.

The body is built of steel, sheet metal, and aluminum. "On a high-speed run of 55 mph, with a 25-foot drop, the Land Master suffered no damage," Jeffries said.

All doors are weather-stripped, and the lower part of the machine is waterproofed with a sealer similar to undercoating. In one scene, the Land Master floats across Flat Head Lake, Montana.

Mounted on the Land Master are six cannons operated by remote control, and a pair of armor-piercing bazookas. The vehicle is equipped with closed-circuit television, a radar scanner, two bunk beds, shower, and bathroom.

Powering the huge machine is a Ford 391-cubic-inch industrial truck engine equipped with special headers by Cragar and an intake manifold by Edelbrock.

Jeffries said it took his shop nearly three months to build the Land Master—"the biggest and toughest challenge" of the car builder's long career. His most difficult project before that was the moon vehicle used a few years ago in the James Bond thriller, "Diamonds Are Forever."

If you think a Land Master might come in handy and wonder about its cost, Jeffries would only say that it was in the six-figure category. PS

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On the way: power for electric grids from **fuel cells**

They're scaling up an old idea into a new breed of super-efficient power plant

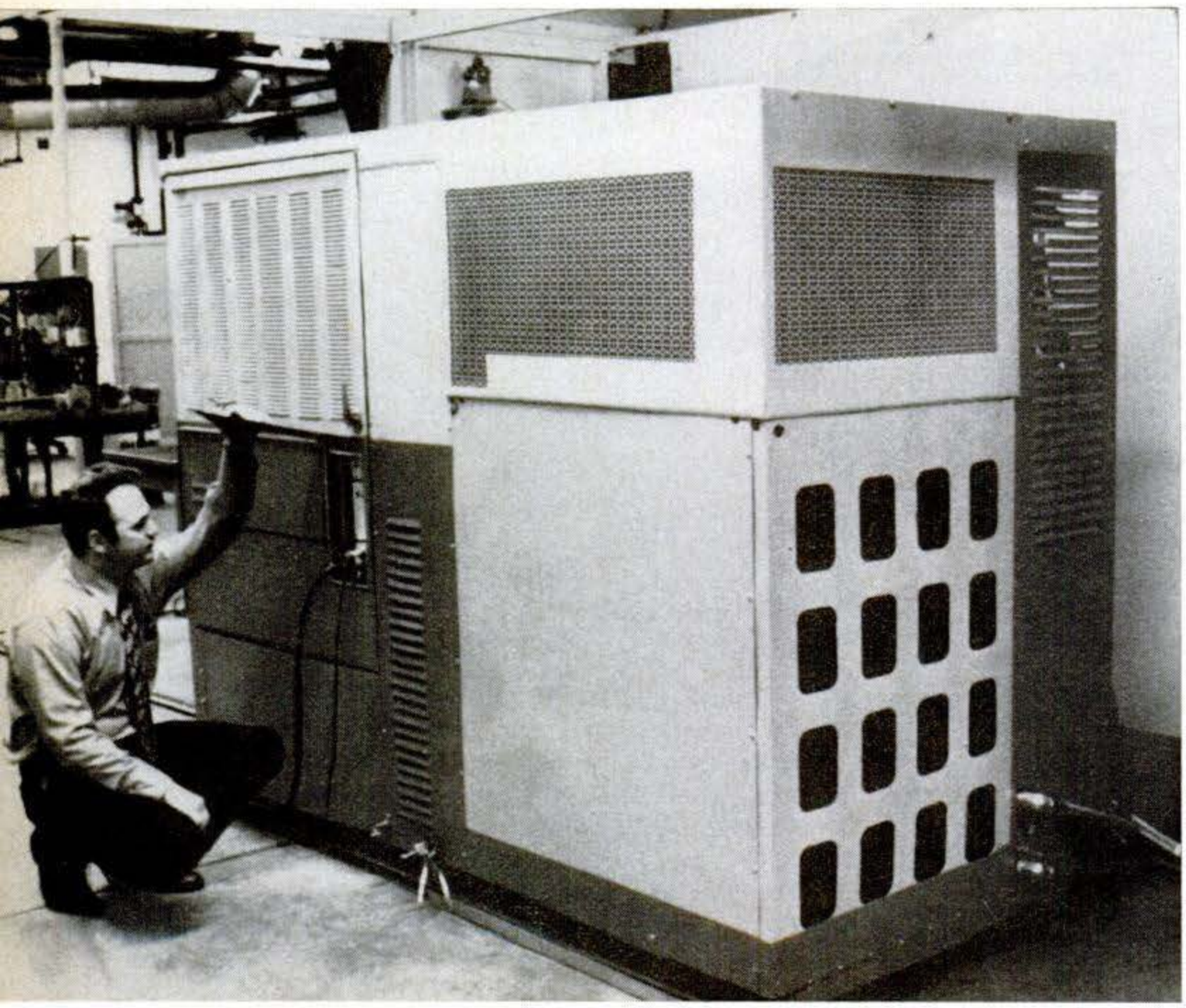
By ROBERT GORMAN

After kicking around in the back alleys of science for 138 years, the fuel cell, a battery-like device that generates direct-current electricity by chemical action, has suddenly been plunged into a desperate race against time.

Because the outcome could be important to our environment, our economy, and our fuel resources, the federal government—through the Energy Research and Development Administration (ERDA)—is paying for most of a $42-million, two-year test program.

The goal is completion of a five-megawatt fuel-cell demonstration module by 1978. The five-MW plant should expedite development of utility-size 27-MW plants by the early 1980's.

There is a variety of new technological approaches to fuel cells under development. Large-scale systems planned for the early 1980's may use phosphoric acid as an electrolyte because it is tolerant to CO_2 and permits operation with a variety of hydrocarbon fuels. Advanced cells being developed use high-temperature molten carbonates or alkaline electrolytes. These second-generation, highly efficient cells may even be able to operate with "dirty" fuels such as residual oils; cell systems planned for the mid-1980's might also use synthetic fuels derived from the nation's abundant coal supplies [PS, Jan. '77].



Huge 40-kilowatt fuel-cell power plant under development at United Technologies Corp. as a product for utilities will be dwarfed by a one-megawatt system slated for testing soon. Testing of a five-megawatt power plant is planned for 1978 with larger systems to come.

Down-to-earth cells

Like a conventional battery, a fuel cell sandwiches an electrolyte between two electrodes and generates electricity by a series of catalyst-aided oxidation-reduction reactions [see box: "How fuel cells work"].

But instead of consuming its own electrodes—as ordinary batteries do—a fuel cell draws its chemical reactants from an external source. Most often, a hydrogen-rich gas is piped to the anode, and oxygen or air to the cathode. This electricity-generating reaction has been described as the reverse of electrolysis (in which an electric current breaks water down into hydrogen and oxygen).

Practical single cells today generate about one volt, at 100 to 200

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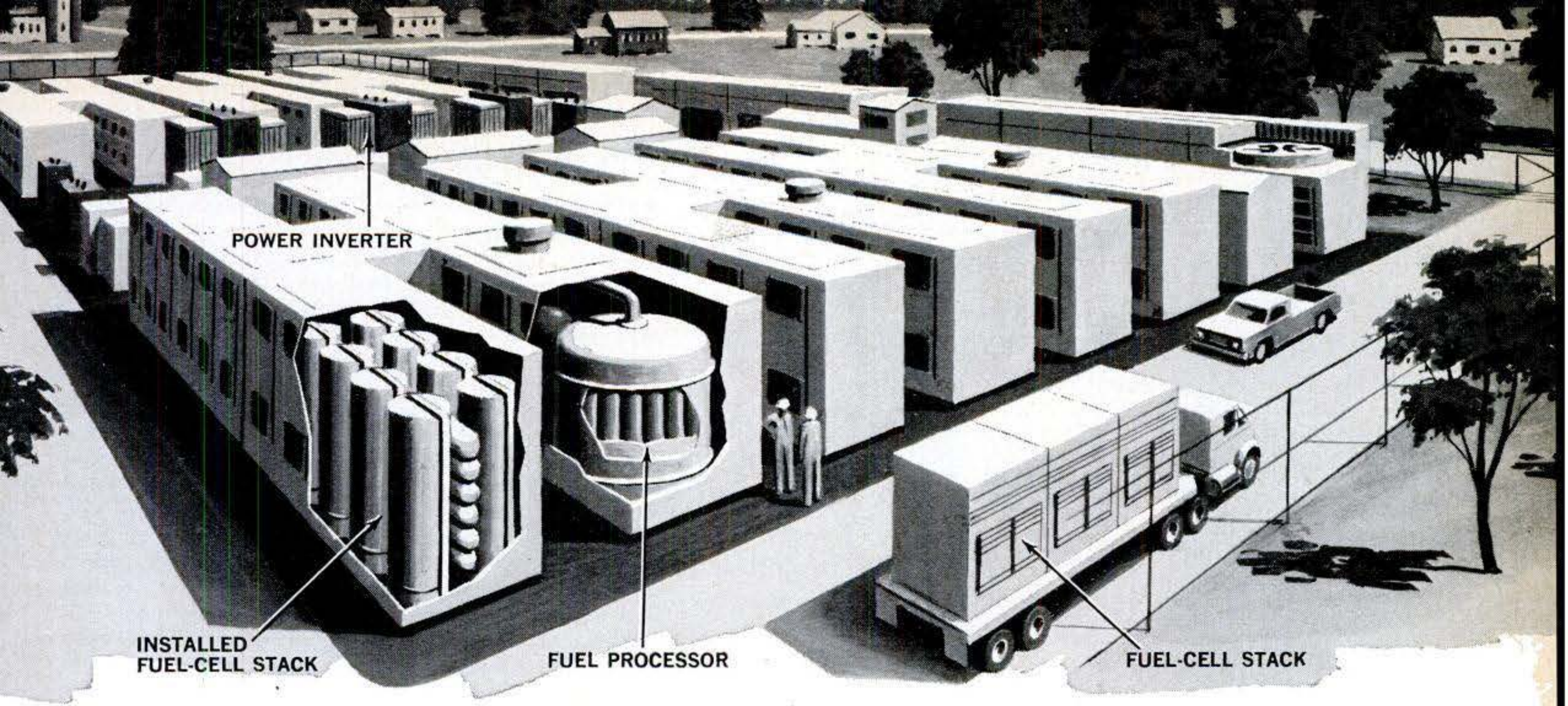
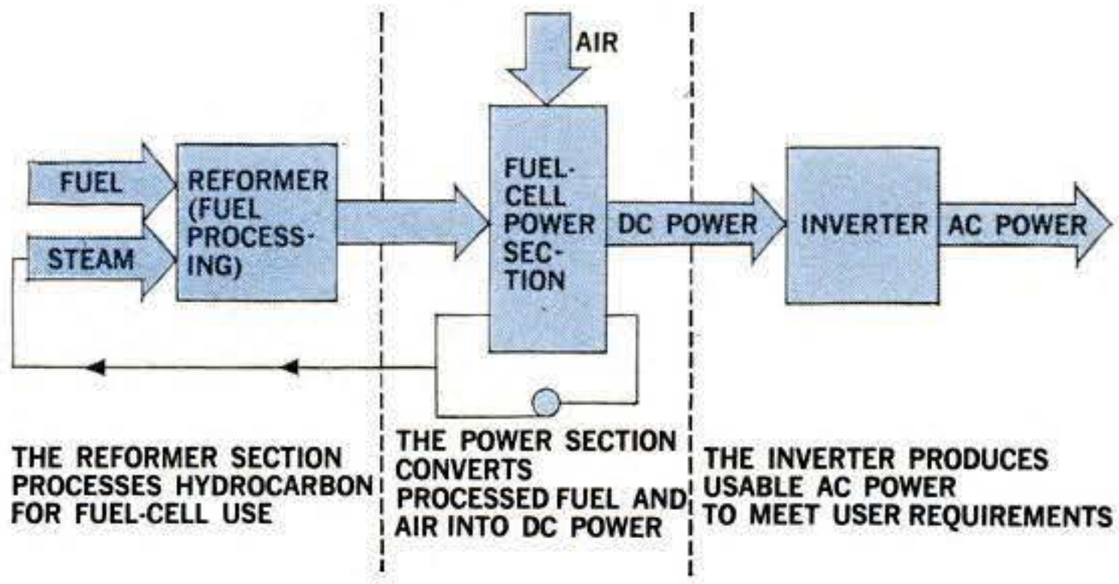


Modular 27-megawatt power plant using fuel cells could be expanded in capacity when necessary as new modules are trucked in. Quiet, clean cells would be ideal for urban or suburban power stations: Their proximity to users would reduce the transmission losses of electricity, and a fuel-cell waste product—steam—could be used for heating. Low-speed fans could cool cells, which convert a variety of processed fossil fuels directly into electricity by an electrochemical process. The fuel processor uses steam to separate hydrogen gas from hydrocarbon-rich fuels. The cells combine the hydrogen with oxygen from the air to generate DC electricity. Power inverters are required to convert the DC into AC used by most utilities. The first-generation fuel-cell system, called FCG-1, is slated for service by 1980. The fuel-cell modules are under development by United Technologies Corp., with support from the Energy Research and Development Administration and utilities.

How a fuel-cell power plant converts hydrocarbons to electric power



watts, per square foot of electrode. Stacks of individual cells can be series-connected to raise their voltage, or paralleled for higher current and power outputs.

The basic principles have been known since 1839, when Sir William Grove, an English judge and part-time scientist, invented the fuel cell. But it wasn't until the dawn of the space age in the 1950's that a few adventurous scientists restudied fuel cells and noted their advantages for remote power generation: continuous power output, which cannot be obtained from conventional batteries; better efficiency; longer life; and their potential for more uniform, controllable performance.

Engineers worked out a number of technical bugs and came up with a system composed of fuel and oxidant storage tanks, a cell stack, and a DC-to-AC power processor. Such a system provided reliable, compact, lightweight electric power for many space vehicles. Even the "waste" products of the chemical reaction—heat and pure drinking water—were put to good use in space to benefit our astronauts.

But bringing these useful features back to earth, scaling them up, and applying economically feasible "this-world" fuels was another story. Much research and development work has been done; much more remains. "If we can lower their cost and improve their durability, the fuel-cell generators could solve a lot of problems," says Dr. Lloyd R. Lawrence, Jr., manager of fuel-cell programs for ERDA.

Boosting temperatures

Most first-generation fuel cells use phosphoric acid for the electrolyte and a limited selection of gaseous or liquid fuels. Some poisoning of catalysts occur (rendering them ineffective) even when feedstocks are kept within narrow limits. For utility applications, a broader range of feedstocks may have to be accommodated.

In the phosphoric-acid system, carbon and small amounts of noble-metal catalysts are used for the electron-conducting components. This system will work with fuel streams containing carbon dioxide and carbon monoxide because acids are able to reject them.

Experts are still arguing over optimum operating temperatures for phosphoric-acid cells. Higher temperature, it's agreed, increases efficiency. But it is also thought such temperatures may reduce cell life and reliability. As of last year, however, the Electric Power Research Institute still felt that an electrochemical breakthrough was needed in the performance of the air cathode to achieve long life and high efficiency.

The need for platinum to catalyze the chemical action has been a serious obstacle to commercially competitive power from fuel cells. A decade ago, the requirement ran as high as 2000 grams per kilowatt; it's now down to 10 and is expected to go lower soon—perhaps to zero. This, along with other production and technical advances, has brought capital costs down from $100,000 per kW in 1968 to about $300 today.

Advanced research is focusing on

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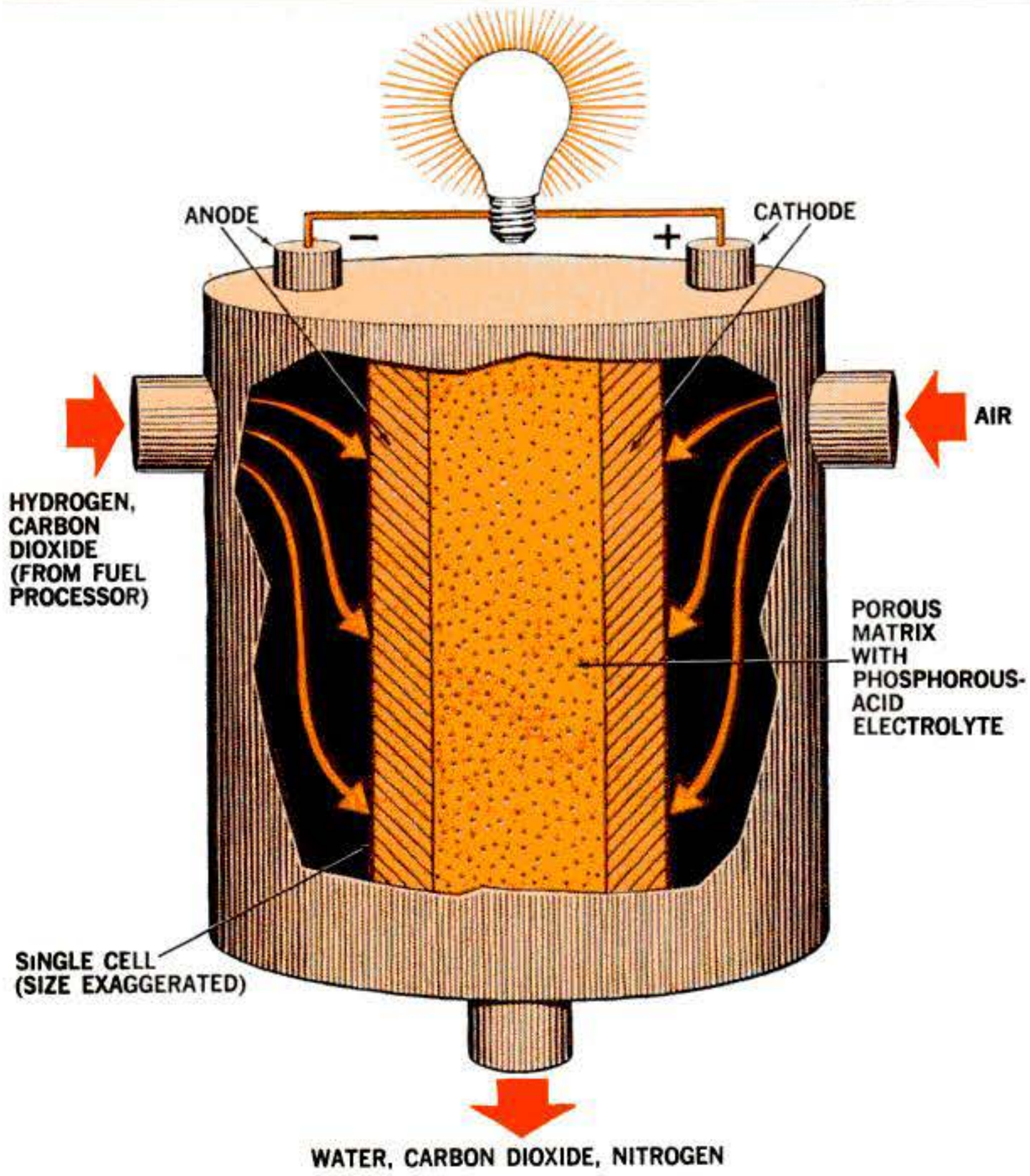

How fuel cells work

A single fuel cell consists of a porous electrolyte matrix sandwiched between anode and cathode plates. Unlike the cells in a battery, which consume their electrodes and built-in chemicals, fuel cells consume externally supplied fuel, usually hydrogen and oxygen. Individual cells generate from 0.5 to about one volt direct current, and must be stacked and connected to boost voltage and current. Fuel from a tank or processor enters the cells as hydrogen and flows down the anode plate, losing electrons and giving the plate a negative charge. When air is supplied to the cathode, oxygen molecules pick up electrons, leaving the plate positively charged. When an external load is connected between the two electrodes, excess electrons on the anode travel through the load to the cathode. Positive hydrogen ions at the anode migrate through the electrolyte solution, and combine with oxygen to produce water. Nitrogen from the air and carbon dioxide from the fuel input (when a fuel processor is used) are also waste products. The electrolyte, phosphoric acid in new cells, can circulate through the porous matrix separating the electrodes, which are also porous. The electrode plates are actually paper-thin carbon sheets containing a noble-metal catalyst such as platinum to aid in the ionization of the hydrogen fuel and oxygen. The electrochemical combination of fuel and air produces electricity with 38-40 percent efficiency; by 1985, 50-55 percent efficiencies are expected.

alkaline and molten-carbonate cells. Both hold promise of higher efficiency (50 percent or more), and are likely to be lower in cost.

A major problem of the alkaline cell is that carbon dioxide, produced by fuel processors, reacts with the electrolyte and interferes with performance. So one focus of alkaline-cell research is on development of low-cost technology for removing this carbon dioxide.

A wider choice of fuels could greatly help the prospects for early work on molten-carbonate cells. This cell type actually involves carbon dioxide in the chemical reaction, so it can easily integrate fuel streams containing carbon dioxide and monoxide.

Higher-temperature, second- and third-generation fuel cells could send power soaring to a new level, opening the way to the exploitation of both wasted and more available fuels. In the first case, cell power plants might be set on top of gas wells with yields too low to be economically transported in pipelines. In the second case, they might be combined with coal desulfurization and gasification.

Utility deadlines

The reasons for the sudden urgency in fuel-cell research are primarily economic—and largely accidental. Research on utility-size fuel-cell generators has been going on for some years. Until now, it has been funded by various companies, most of which have grown discouraged and written off their losses.

Only one major effort survives, for which the impetus—and an estimated $100-million investment—has come from United Technologies Corp. and a group of major utility companies. The effect is now facing critical deadlines.

By 1982, these utilities will have to expand their capacities to meet growing customer requirements, primarily at times of intermediate and peak demand. They have placed tentative orders for new fuel-cell capacity totaling approximately 1.5-billion watts.

And that's only a fraction of potential demand. Reliable studies have shown that about 28-billion watts of present capacity (involving obsolete, inefficient, or environmentally restricted plants) will have to be phased out, replaced, or relocated by 1985. Most of this capacity could be replaced by fuel-cell generators—provided they prove themselves in time.

Fuel-cell generators would have one clear advantage. Conventional intermediate- and peak-load generators operate much of the time at less than full load. These generating systems share one characteristic: Their efficiencies drop off sharply when they are operated below their rated outputs. For example, diesel-electric and steam, or combined-cycle gas-turbine systems (the ones most commonly used for intermediate and peak service) approach 40-percent efficiencies at full load. But that level can be cut by half when demand falls off.

Fuel-cell generators, by contrast, exhibit uniform high efficiency at outputs ranging between 25 and 100 percent of design rating.

High, level, and long-lasting efficiency makes fuel-cell generators attractive to major utilities, for what it really means is that fuel consumption rises and falls in exact proportion to actual, minute-by-minute power demand.

The risk and uncertainties involved in the new pilot program are great. But so are the potential gains, including a possible fuel saving that ERDA projects at 275,000 barrels of oil a day by 1985.

If multi-megawatt systems prove practical, they could broaden our whole energy horizon. In two to three years—if the present ERDA-UTC-EPRI program proves out—we may begin to glimpse the shape of our energy future. PS

FOR FURTHER READING

Wolf Vielstich, *Fuel Cells*, Wiley-Interscience, 1970.
H. Arthur Klein, *Fuel Cells, An Introduction to ElectroChemistry*, J.B. Lippincott Co., 1966.

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Wankel Fanliner

Fanliner's wraparound windshield gives pilot wide-angle visibility. The shrouded propeller is behind cockpit and wing.

This radical new private plane uses a ducted fan for jet-smooth flight

By BEN KOCIVAR

MUNCHEN GLADBACH, GERMANY

Imagine yourself flying a little two-seater that combines the visibility of a helicopter with the smoothness of a jet. Sound impossible? Not to the people at Rhein-Flugzeugbau, an affiliate of Germany's VFW-Fokker. Within the next year, they plan to produce and market the Fanliner, an unusual new private airplane. Its power plant? The fascinating, controversial Wankel engine.

We've had many promises of new airplane designs—but few have not been based on concepts dating back to before World War II. As you can see from these pictures, however, the Fanliner is really different—an exciting-looking plane.

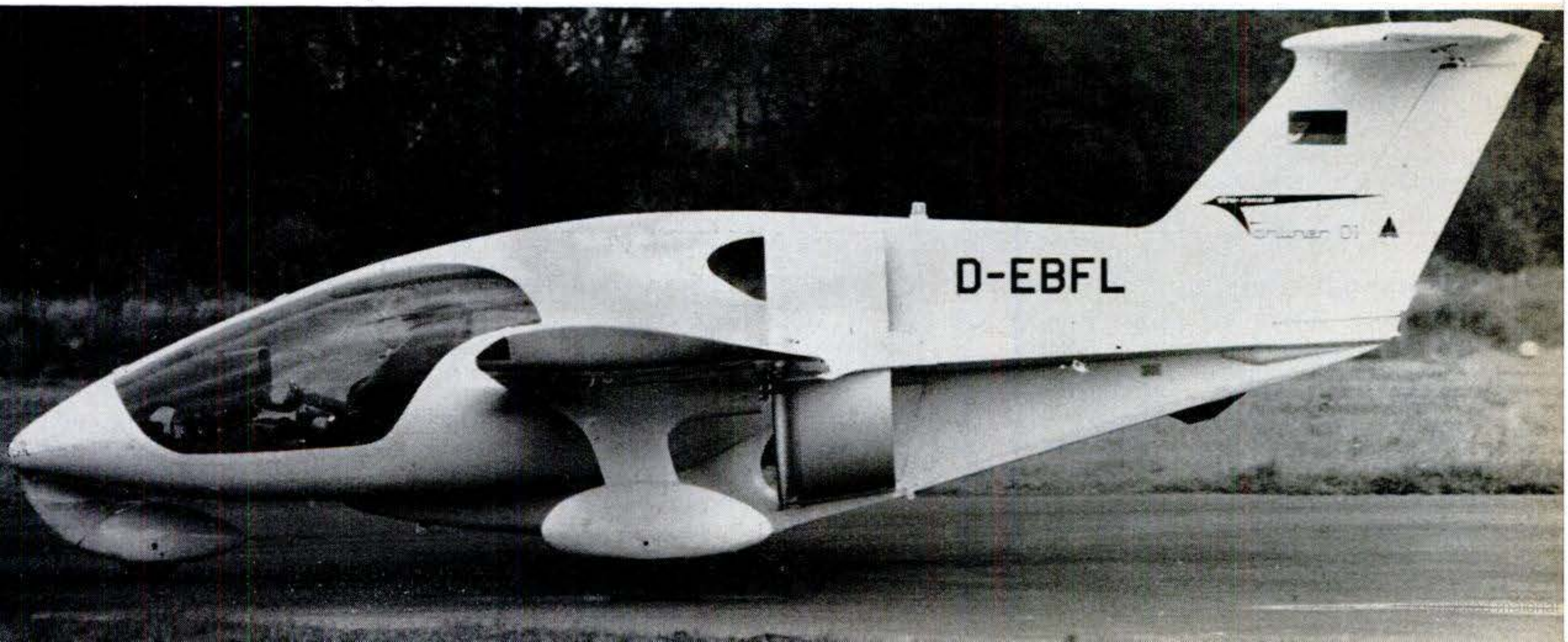
The cockpit visibility is fantastic. I flew the original prototype, and can report that you get the kind of view you get from a helicopter's bubble. With our increasingly crowded skies, that's a big plus.

Equally interesting is the power concept. The most important postwar development in civilian aircraft was the use of jet-turbine engines. But these are very expensive, and today are used only in larger executive aircraft and airliners.

The propulsion system of the new

Continued

Sleek Fanliner sits close to the ground on nonretracting landing gear fitted with streamlined wheel pants. Ducted fan gives greater thrust efficiency.



Fanliner is based on an Audi/NSU 150-hp dual-rotor Wankel piston engine, modified by Rhein-Flugzeugbau. Because of its light weight and small frontal area, this engine can be integrated with a ducted fan, a small propeller encased in a duct or shroud. It's similar to the front bypass fan used in big fan-jet engines. The fan's four blades are much shorter than those of a conventional propeller, giving it lower tip speeds; this makes for a much quieter aircraft than the conventional two- or three-bladed prop airplane. And, because the Wankel engine and fan are mounted directly behind the wing and cockpit, you get that great, unobstructed view.

PS pilot tests plane

The Fanliner I flew had done about 420 hours in three years of flight time. Before I took the stick, only test pilots had flown it—*Popular Science* is the first publication to have a reporter pilot aboard.

What's it like to fly? First, I had to get accustomed to the sky-wide visibility from the cockpit, and to the strange feeling of sitting low down, closer to the ground, (the plane doesn't need ground clearance for a big prop).

The test pilot, Helmut Knoepfle, taxied out to the main runway, then held the brakes and ran the engine up to full rpm. Surprisingly, this airplane with its liquid-cooled engine requires no warm-up. It's pretty much like a jet engine: You go as soon as engine rpm comes up to power speed, less than one minute after starting. No warm-up time means little wasted fuel, and no delays in taxiing out to a take-off point. And that means less wear and tear on the engine itself.

Knoepfle told me some other advantages the Wankel engine provides:

- Smoothness. If you've ever driven a car with a rotary engine, you can imagine the turbine-like, silky quality of this engine in an aircraft. The lack of vibration translates into less fatigue for the occupants, and less stress on the many connections holding the airplane together.
- Safer flying. With the Wankel rotary engine, in contrast to conventional reciprocating engines, there is no possibility of engine blockage due to piston failure. This reduces the possibility of engine failure in flight.

As Knoepfle talked, he released the brakes and we started to roll. At this point, I was reminded of my first jet ride, in a Lockheed T-33 jet, about 25 years ago. Like the old jets, the Fanliner has a steady and continuous push as it builds up speed. Takeoff time was comparable to that of the piston-engine Grumman American Trainer; it took the Fanliner a little longer to get up than a Cessna 150 or a Piper Cherokee.

Lower noise levels

The noise inside the cockpit at this point was slightly lower than in a conventional propeller airplane. (Outside, 1000 feet away, Knoepfle said, noise had measured at 74 dBA at full throttle—a big advantage for reducing noise pollution at small airports.)

At about 90 miles per hour, we climbed about 1000 feet per minute, which compares quite favorably with similar-horsepower conventional planes.

But the Fanliner's engine ran up to a maximum rpm of 6000, more than double that of a conventional reciprocating engine on a small light plane. Knoepfle said you could run the engine continuously at 6000 rpm, its optimum performance speed, without damage or fear of overheating. But a propeller turning at that speed would be much too noisy, so it has been geared back to 3600 rpm.

At about 4000 feet, we leveled out, trimmed the airplane, and flew it awhile hands off. It was extremely stable. Knoepfle demonstrated a few turns to show me how the airplane held the turns without wobbling. Then I tried some and found the control system a little bit on the heavy side. He explained that this was simply a matter of a too-tight linkage—a relatively simple fix.

The design of the engine installation makes for interesting effects, different from those you find on conventional private planes. When we stopped the engine, for example, the airplane stayed in a clean configuration, pretty much the way a jet aircraft does. Since there is no prop hanging out in the airstream to cause wind resistance, the plane has a much flatter and longer glide than airplanes with propellers in front, such as the Cessna. This gives the plane a feel similar to that of a jet-engine aircraft, and you handle it like one.

And there's no sense of torque or twist of the plane's body when you hit the throttle suddenly. Many conventional airplanes have a tendency to twist in counter-reaction to suddenly increased engine torque, and the pilot must control the plane carefully to compensate. But the Fanliner's reaction to torque is very much as with a jet engine, and there's no need for compensating control.

Nor is there need to adjust the elevator trim control when moving the throttle. Unlike conventional planes, the Fanliner doesn't pitch or change longitudinal angle with changes in throttle settings. Again, this is much like flying with a turbine engine.

Besides its smooth, jet-like feel, the Fanliner racks up impressive performance figures. This little two-seater with its 150-horse engine can cruise at about 150 mph, has a range of about 800 miles, and can fly about 6½ hours.

Back on the ground, I climbed into the preproduction version of the Fanliner to see how it differed from the plane I had just flown. This Number II Fanliner had only about four hours of flight time when I saw it. It is a most impressive airplane. The cockpit has been expanded to provide an even more panoramic vision. And many of the minor bugs I'd noted in my flight had been worked out in this version:

Other advanced designs in the works at VFW-Fokker

A Fanliner spinoff will be the Fantrainer AWI-2. I saw the mockup and partial construction of this two-seater. Designed as a trainer for jet pilots, the AWI-2 will have a 300-hp rotary engine. The idea is to give the trainees the feel of a jet without the expense of purchasing an actual jet.

Unlike the Fanliner, the Fantrainer has a retractable landing gear and a sturdy keel along the bottom of the fuselage. I was told that if something were to go wrong with the landing gear, the keel would permit the plane to land with the gear retracted. Rhein-Flugzeugbau, which modified the Wankel engine, says that such a landing would probably cause little, if any, damage to the engine or the ducted power plant.

The Fantrainer should be flying next year. In advance literature, RFB estimates that the savings in training only three pilots will cover the total initial cost of one Fantrainer. That's a pretty substantial promise.

The people at VFW-Fokker are also working on a number of other rather exciting concepts. In my report from the Hanover Air Show [PS, Nov. '76], I described a semiportable ducted-fan installation that can be mounted on top or side of a glider to convert it to a

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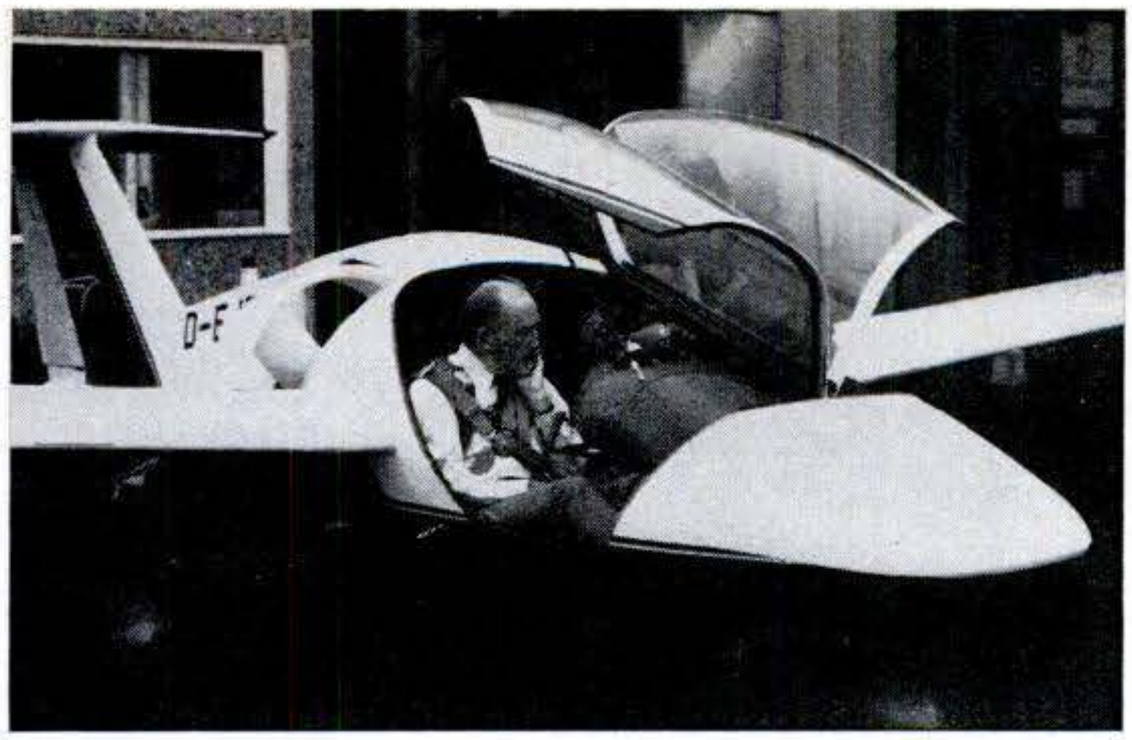

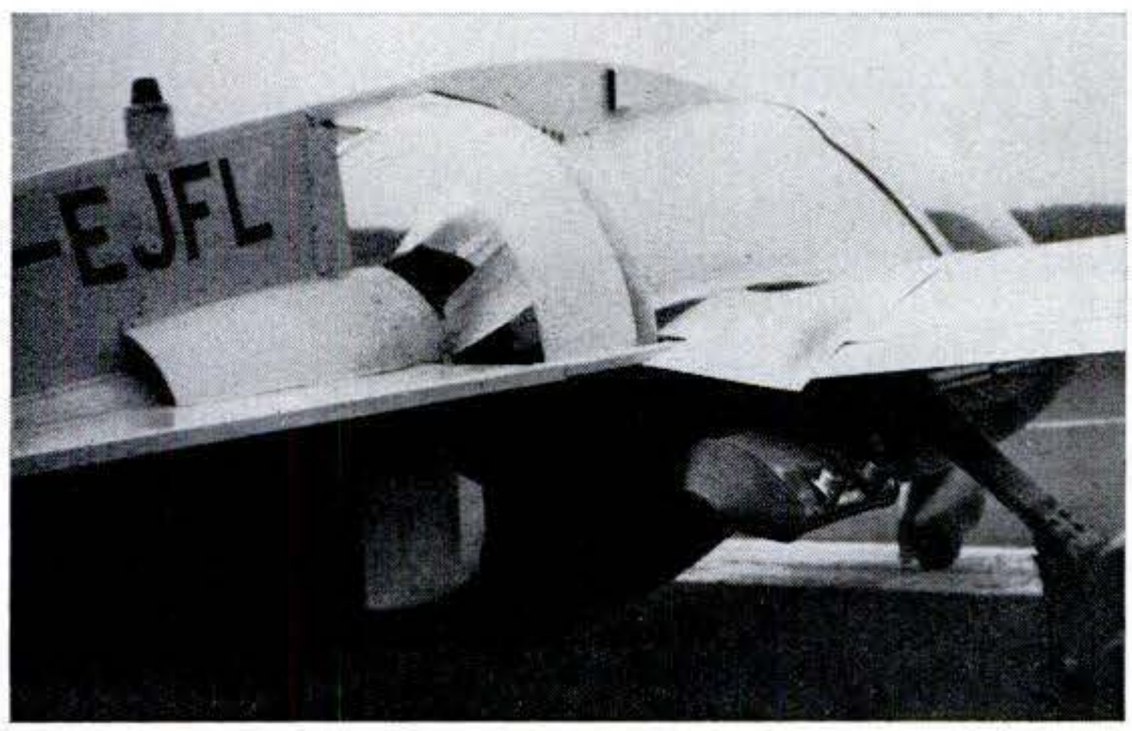

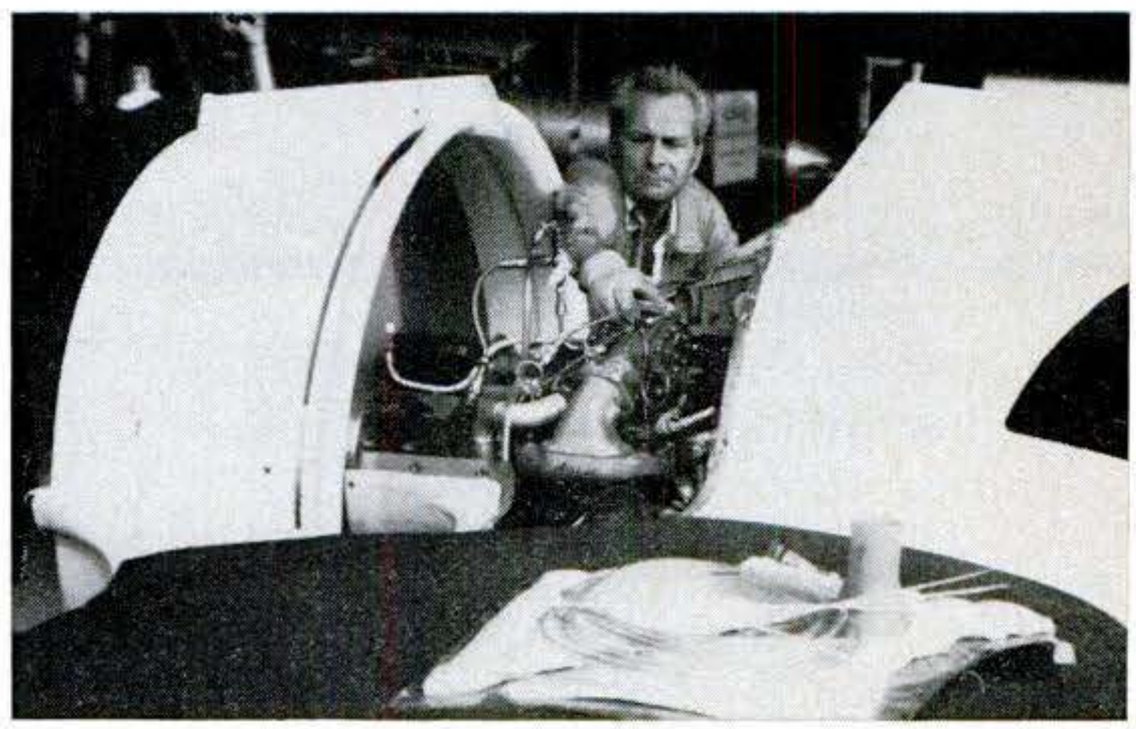

Author Kocivar compares cockpit layouts of original Fanliner (upper left), which he flew, and the improved preproduction model (upper right). Roomy cockpit makes Fanliner easier to step into than most light planes. Ducted fan behind cockpit (lower left) produces less noise than standard props on other light planes. The liquid-cooled Wankel engine (lower right) is mounted directly behind the cockpit, ahead of the ducted fan. Cooling system uses water with antifreeze and anticorrosion additives. The wings and tails on both Fanliners are from Grumman, which may cooperate with RFB in final production and marketing. Scuttlebutt is that the Fantrainer two-seater may be the first production plane that uses a rotary engine.

• The Fanliner II uses a special aircraft transmission that is lighter and less noisy than the Mercedes transmission originally used. Noise levels are 10 points lower than the plane I flew—65 dBA at 1000 feet, I was told. This transmission will also drain off less power, improving the performance figures.

• The controls are easier to handle due to the fix of the tight linkage mentioned earlier.

• The Fanliner II is sleeker and has a slightly large wing. On this plane, stall speed is about 10 mph lower than on the earlier version.

After checking out the snazzy controls on the Fanliner II, I asked the big question: How much will it cost? Current estimates hover around $35,000. That's not cheap —it's about twice as much as the cost of today's propeller-driven two-seaters.

Is it worth it?

However, the Fanliner is not just another conventional plane. It has jet-like smoothness. It has very nice control characteristics. The extremely good visibility is obviously going to make it much safer and more fun to fly. In addition, this cockpit is the widest production-airplane cockpit of any now being made, actually 25 percent wider than the comparable Grumman American airplane.

The other obvious advantage, of course, is the Fanliner's lower noise levels. There are already laws limiting the amount of noise from local airports, and the trend is toward even stricter laws.

Finally, this airplane has advantages for pilots who want to make an eventual transition to jet aircraft. It has a price advantage over jet planes.

Will anyone pay more, almost twice as much, for those advantages? Well, some people will buy a Mercedes or a Cadillac, and others opt for a Volkswagen or a Chevrolet. Within the next year or so a similar choice should be available to American pilots. PS

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powered sail plane. This installation is light—the three-bladed prop is contained in a foam-plastic shroud—and apparently simple to make.

An even more unusual machine is an airfoil boat. This is actually a low-flying, winged seaplane that attains lift by using ground effect. (Ground effect is the compressed layer of air that flows under the wings of an airplane that's flying close to the ground or water.) By flying low, this specially designed machine can get airborne and stay there, using less horsepower than it would take to fly to higher altitudes.

An early one-seater version has been test-flown at 140 kph, using only a 40-horsepower engine. Now VFW-Fokker is working on a six-seater version.

The advantage of being able to move over water at fairly high speeds using low horsepower should make these airfoil boats competitive with comparably sized hydrofoils and air-cushion vehicles, which require relatively smooth water surfaces in order to operate efficiently. By contrast, airfoil boats flying low over the water can operate over rougher seas.

These ground-effect vehicles could be used to cover long distances over rivers, or to provide crossings over harbors and bays. They should be especially suited for use in countries that have poor highway systems.—*Ben Kocivar*

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Microprocessors

Tiny overseers that run everything—from cars to ovens

Computers-on-a-chip will make the driving easier —and cut fuel consumption

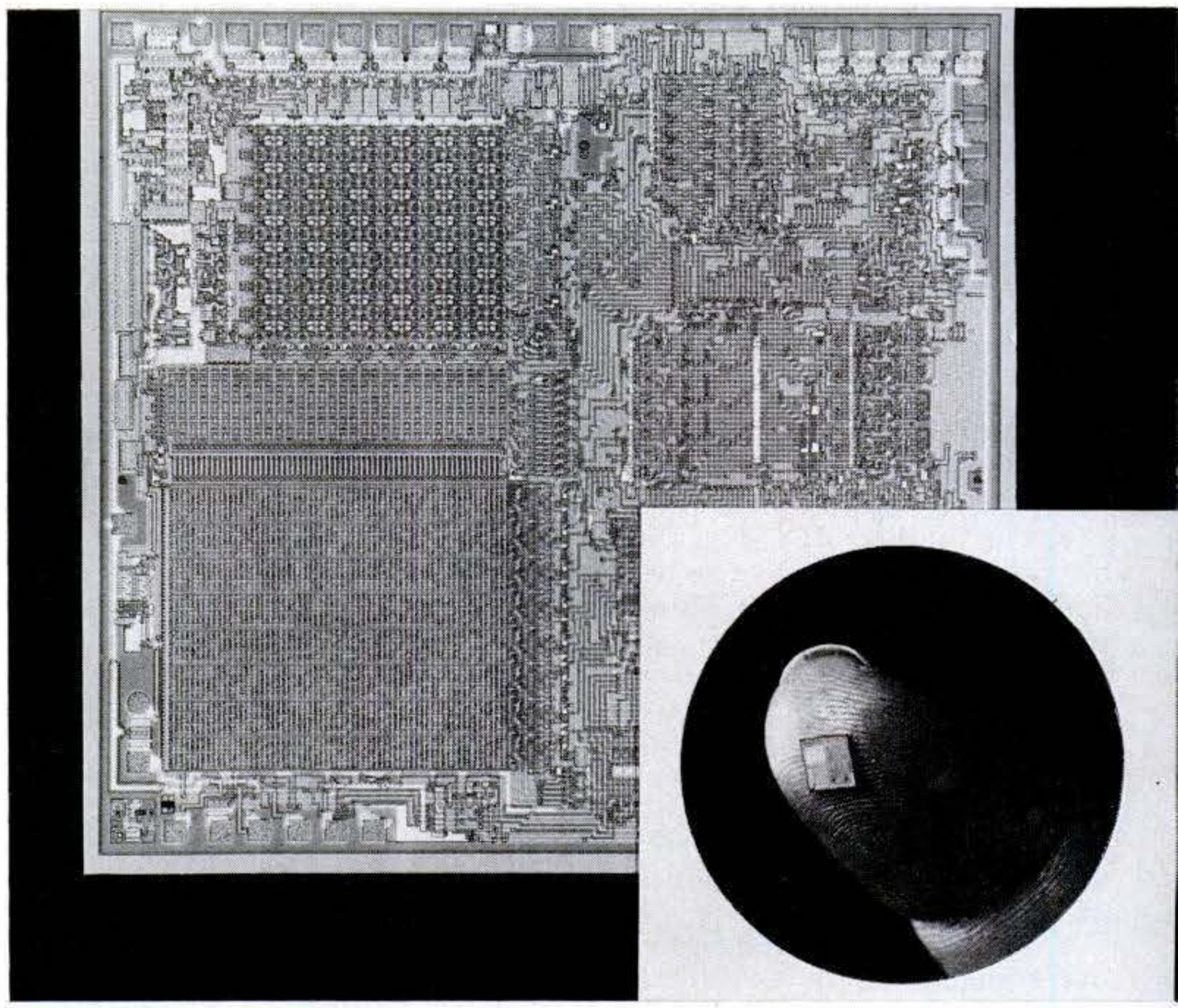
By JOHN FREE

Robert Wilson revs up his 1977 Oldsmobile Toronado each morning and heads down the tollway to an accounting job in downtown Chicago. Wilson is unaware of the book-size electronic circuit board nestled behind the Toronado's dashboard. But the circuitry, actually a sophisticated digital computer, makes Wilson and some 35,000 other Toronado drivers this year pioneers in a revolutionary new development in the automotive field.

Two tiny microcircuits on the board—much like those in pocket calculators—sample the Toronado's manifold vacuum, coolant temperature, and crankshaft position through sensors. The microcircuits consult 350 memorized data points, perform thousands of calculations each second, and send out signals to fire the V-8's spark plugs. As a result, Wilson pockets a 1.2-mpg fuel saving from his Toronado—a model not especially noted for its fuel economy.

"This advanced electronics system will continually adjust ignition timing for the best fuel economy, driveability, and emissions performance under the broad range of driving conditions that our customers put their cars through," GM president Elliott Estes said when it was introduced.

Within a few years, similar microcomputer circuits are expected to take over more engine-control, auxiliary, and display functions in cars.



Computer-on-a-chip is about one-sixth of an inch on a side. Just introduced by Rockwell International, the chip carries four complete circuits needed for a microcomputer: two types of memories (the squarish areas on the left), a central-processing unit, and input/output circuitry. By changing the program in one of the memories, the microcomputer can be used for electronic games, cash registers, controllers for printing mechanisms, or a variety of other applications.

Experts predict eventual mileage gains of 20 to 40 percent through the use of onboard computers, which will also handle everything from antiskid braking to alarms that prevent you from dozing off behind the wheel.

Microprocessor explosion

Although microprocessors, the heart of digital microcomputers (see box), have nudged into the automotive field only this year, they've recently made spectacular advances in other areas. Sometimes called the computer-on-a-chip, microprocessors are turning up in microwave ovens, hi-fi equipment, telephones, gas pumps, traffic lights, hobbyist and scientific computers [PS, Dec. '76], point-of-sale terminals, wash-

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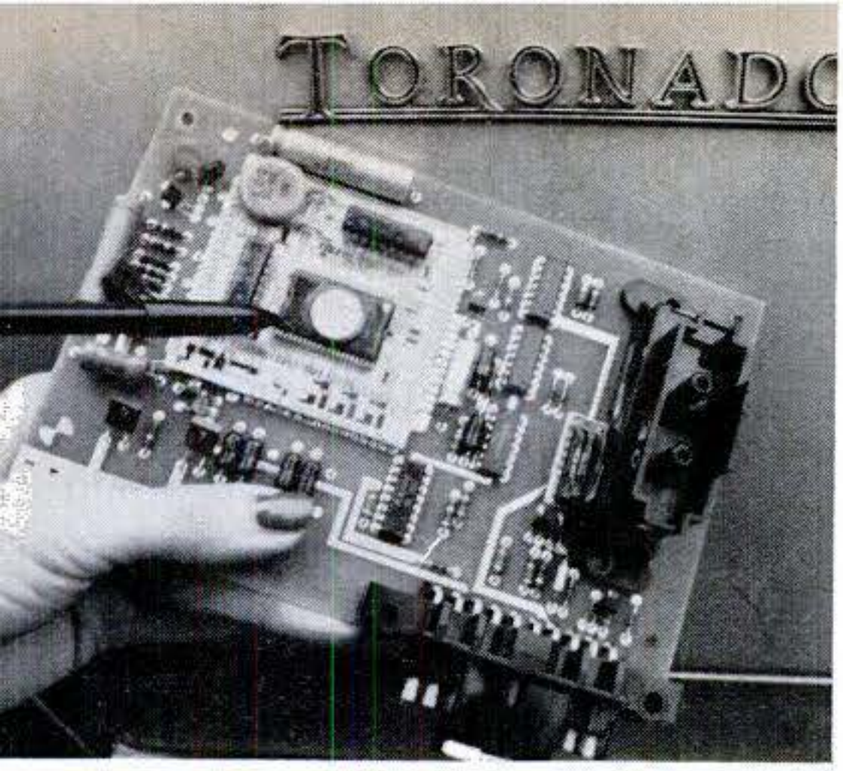
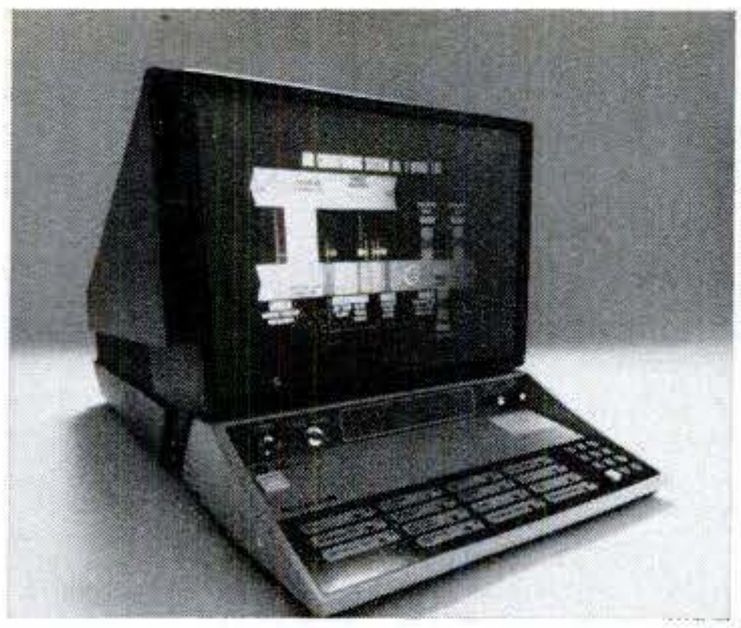
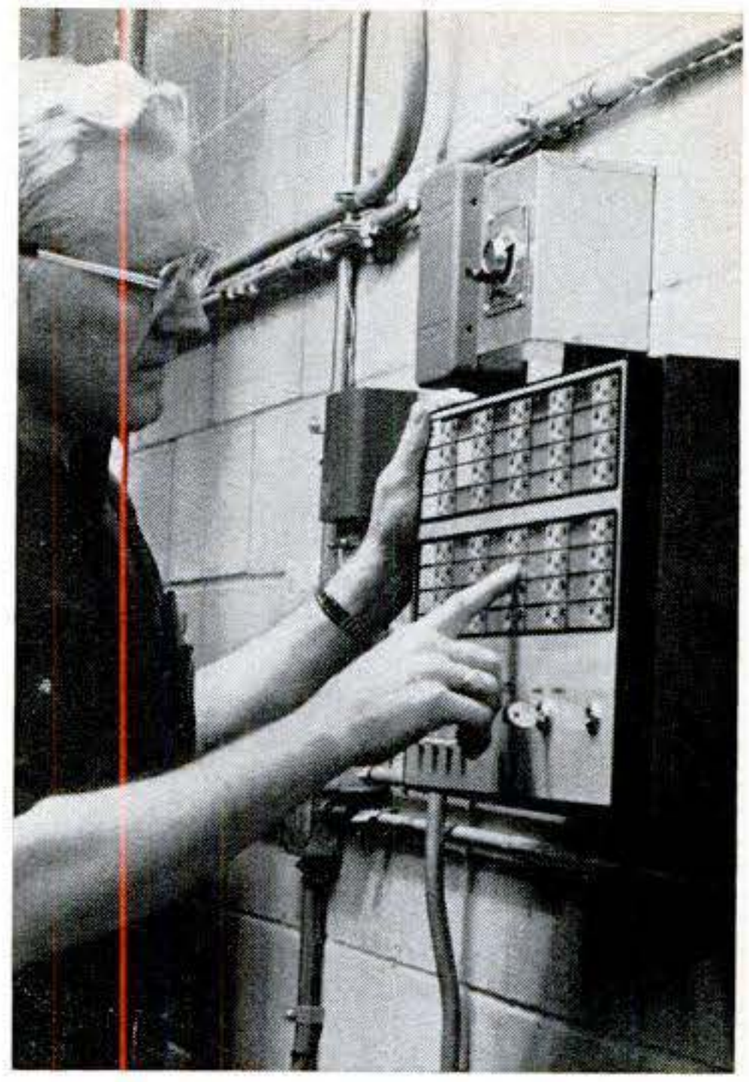
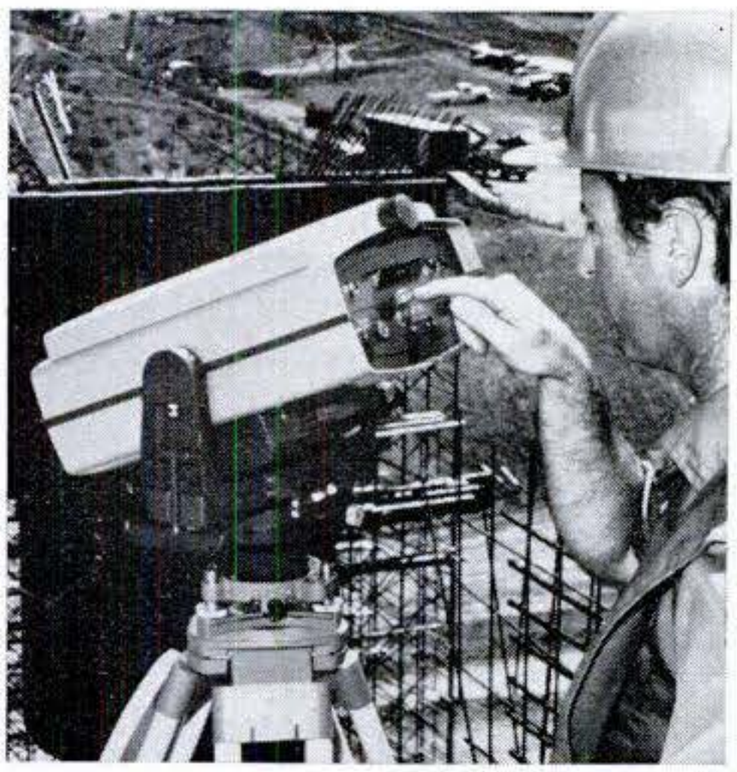






Saving fuel in cars and buildings

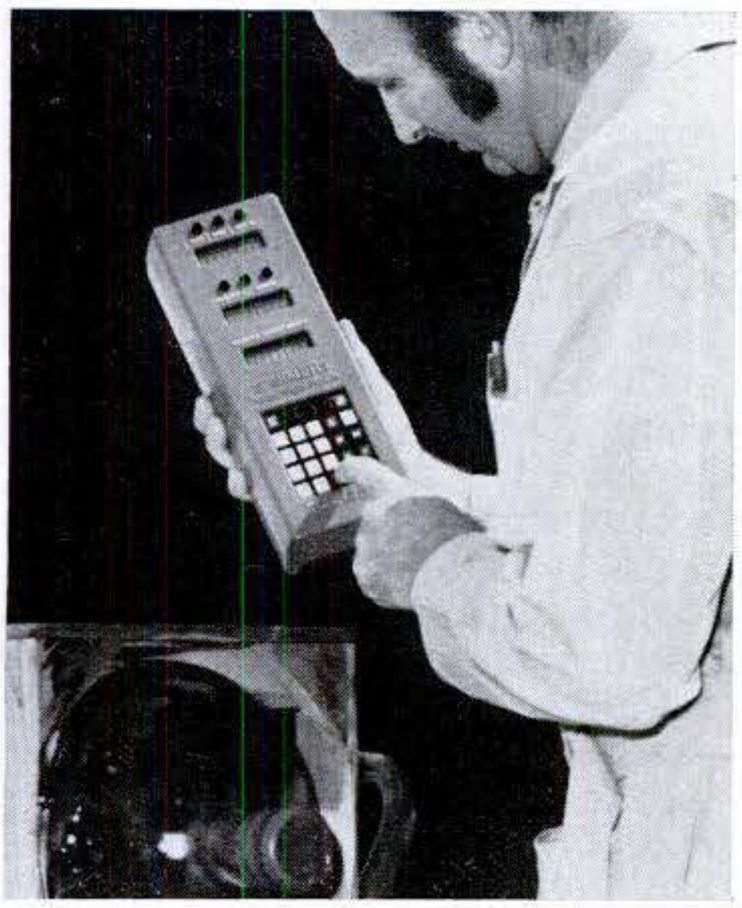
Computerized spark-timing system in this '77 Oldsmobile uses a special microprocessor (pointer) on the control board. Sensors constantly measure engine vacuum, temperature, engine speed, and crankshaft position. The controller computes the best firing time. System saves about 1.2 mpg. The new Delta 1000 central-control system can save at least 20 percent of the energy used to heat and cool buildings, says Honeywell. Desktop control panel, right, displays slides of building systems. Pilot-light modules, far right, show equipment status or alarms. The computerized system is practical for smaller buildings.



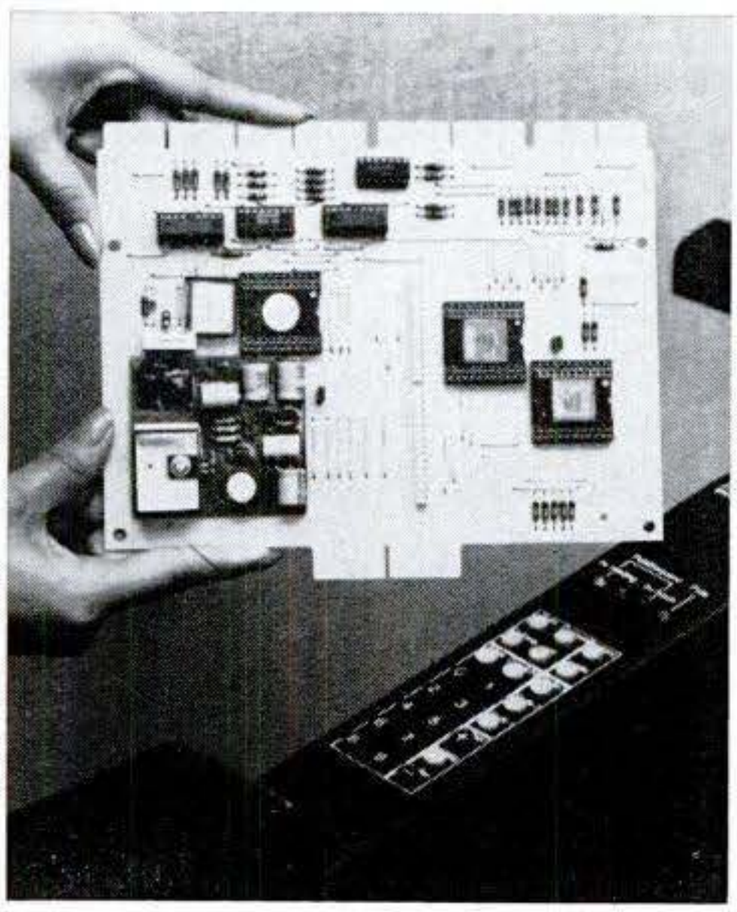
Surveying station saves 30 to 60 percent of the time normally needed to complete a project, says Hewlett Packard. A microcomputer and infrared beam compute distance, angles, slopes.

Electronic bartender automatically mixes drinks and calculates the price. The 48-button control panel works with a specially programmed microprocessor made by National Semiconductor.

Credit-verification phone enables merchants or banks to check credit-card transactions in seconds. Bell Labs engineers programmed Rockwell's PPS-4 microcomputer-chip set (foreground).



Portable computer terminal eliminates bookkeeping drudgery by recording daily sales operations for transmission over phones to big computers. Wordsmith, Inc. markets the device.



Bicycle exerciser made by Keiper in West Germany uses microcomputer (above) to load the pedals, based on weight and age. A warning light flashes if a sensor detects an abnormal pulse.

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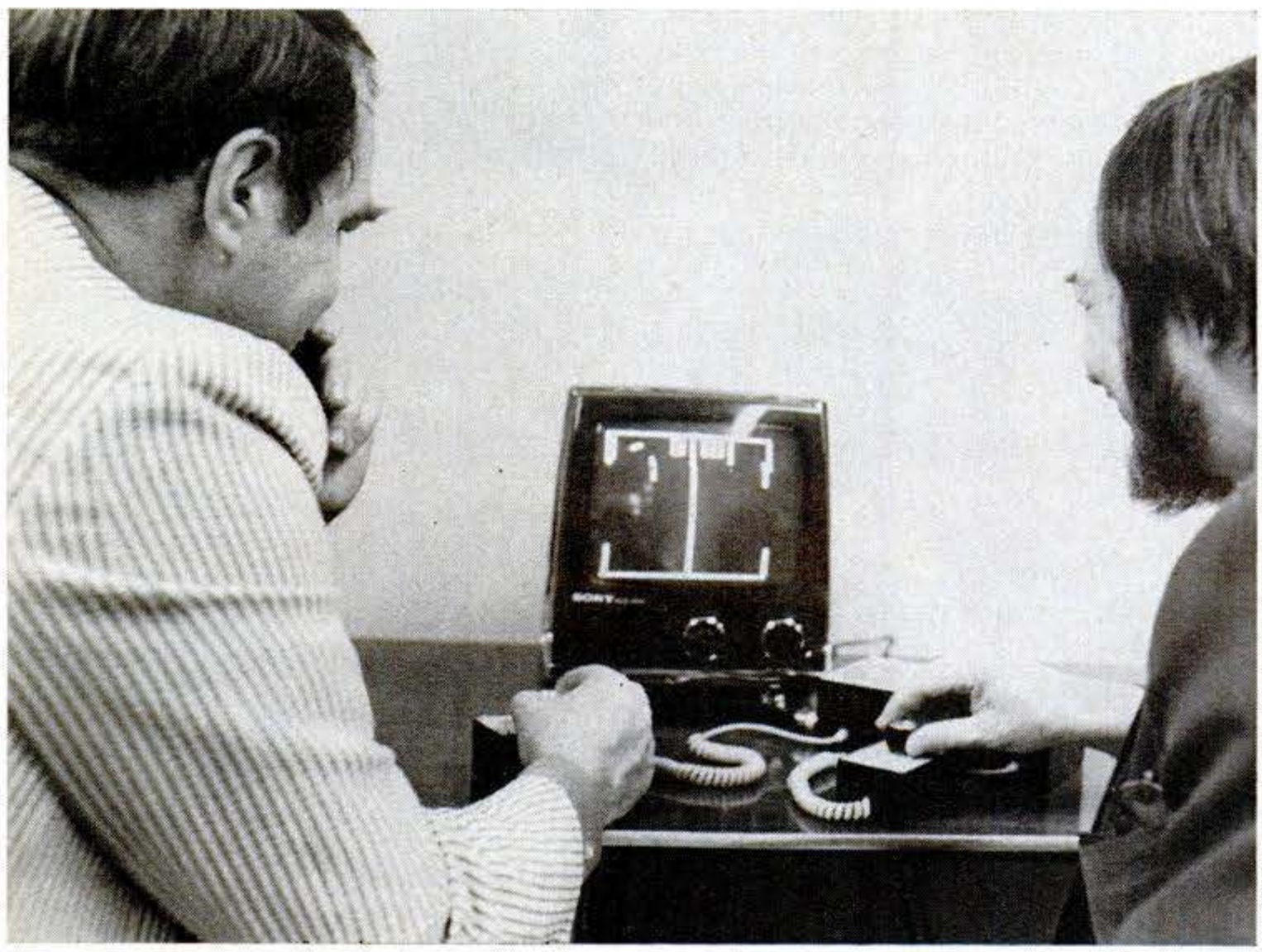
ing machines, electronic games [PS, Nov. '76], test equipment, and hundreds of other applications (see photos).

Shrinking the computer

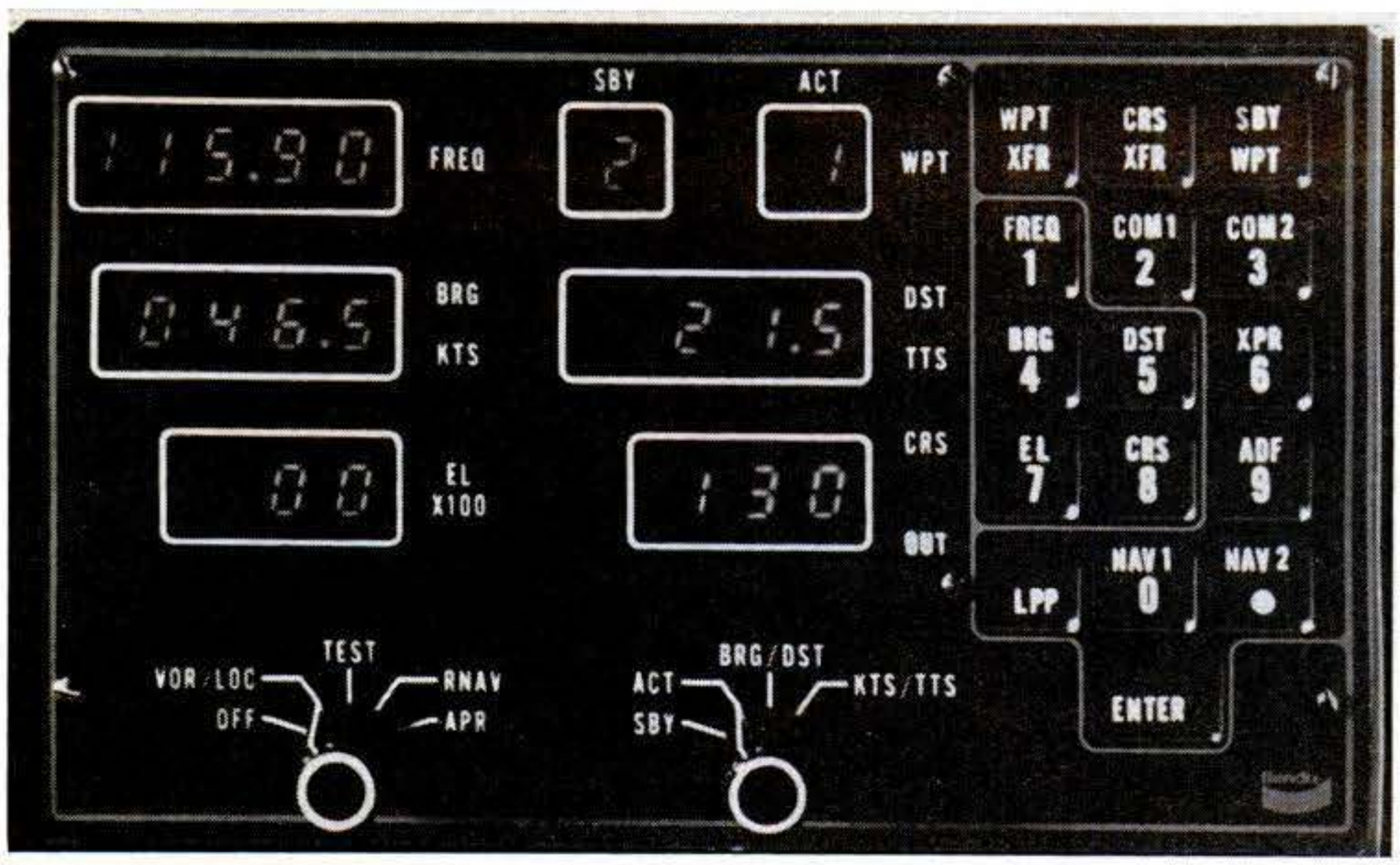
The low-cost microcircuits are making switches, gears, levers, springs, and relays obsolete in many industrial applications, just as calculator microcircuits doomed the electro-mechanical innards of early calculator models. And although the tiny circuits lack the power of larger modern computer systems, engineers are learning how to link numerous microprocessors together into supercomputers

Microprocessors became feasible in the late 1960's with the introduction of large-scale integration (LSI) to microcircuit technology. Refinements in metal-oxide semiconductor (MOS) technology made it possible to form thousands of transistor circuits—entire prewired electronic systems—on silicon chips. Pocket calculators and digital wristwatches are one highly visible application of LSI.

Before MOS and other forms of LSI, engineers had to select dozens or hundreds of medium-scale-integration (MSI) packages, each carrying about 50 to 100 microcomponents, or ordinary integrated circuits (IC's), with still fewer components. These microcircuits, each performing different digital-logic functions, were permanently hard-wired together on printed-circuit boards. One outsanding result of this design approach was the relatively low-cost, cabinet-size minicomputer that, beginning in the mid-1960's, revolutionized the industry.



Video games using microprocessors enable players to select TV tennis, hockey, skeet shoots, and other games. Here, engineers from General Instrument Corp., which has made over five million game chips, try their skills.



Navigation programmer is part of a series of microprocessor-based equipment for general aviation. Introduced by Bendix last year, the programmer can store 10 sets of inbound/outbound courses and frequencies.

Stored logic

Engineers at several firms reasoned that, rather than wiring many standard digital-logic circuits together, it would make sense to design a general-purpose chip that could easily be programmed to duplicate the logic functions of most standard chips. Logic programs could be stored on a memory chip and called into use in microseconds.

Intel Corp. began marketing such circuits, the 4004 and 8008 microprocessors, in 1971, and has been joined by other semiconductor manufacturers in producing families of microprocessors.

Storing digital-logic sequences on memory chips by some estimates, makes it feasible to eliminate up to 200 IC packages permanently wired together—an incredible advance. Such a memory circuit, combined with a microprocessor and input/output circuits, forms a microcomputer. (The microprocessor itself may be distributed on one to five LSI chips.)

Using microprocessors, an electronic system that normally required a typewriter-size case and hundreds of dollars can fit on a five-by-seven-inch circuit board at a very low cost. The introduction this year of single-chip microcomputers should soon push costs for most of a system's circuitry to below five dollars (for large orders).

Automotive sensors

Low cost, of course, is fundamental for mass-produced automobiles—but that's not all. The enormous reduction in the number of circuit connections on microcomputers makes their reliability better than that of hardwired systems. Extreme heat, cold, humidity, and vibration as found in cars are often tougher on electronic parts than in some aerospace applications. It makes Detroit executives very cautious.

"If we get to the point where 50-million cars contain a certain electronic component vital to the engine's operation, and we have a failure rate of only one per thousand," explains Ford's president Lee Iacocca, "then we're talking about 50,000 disabled cars!"

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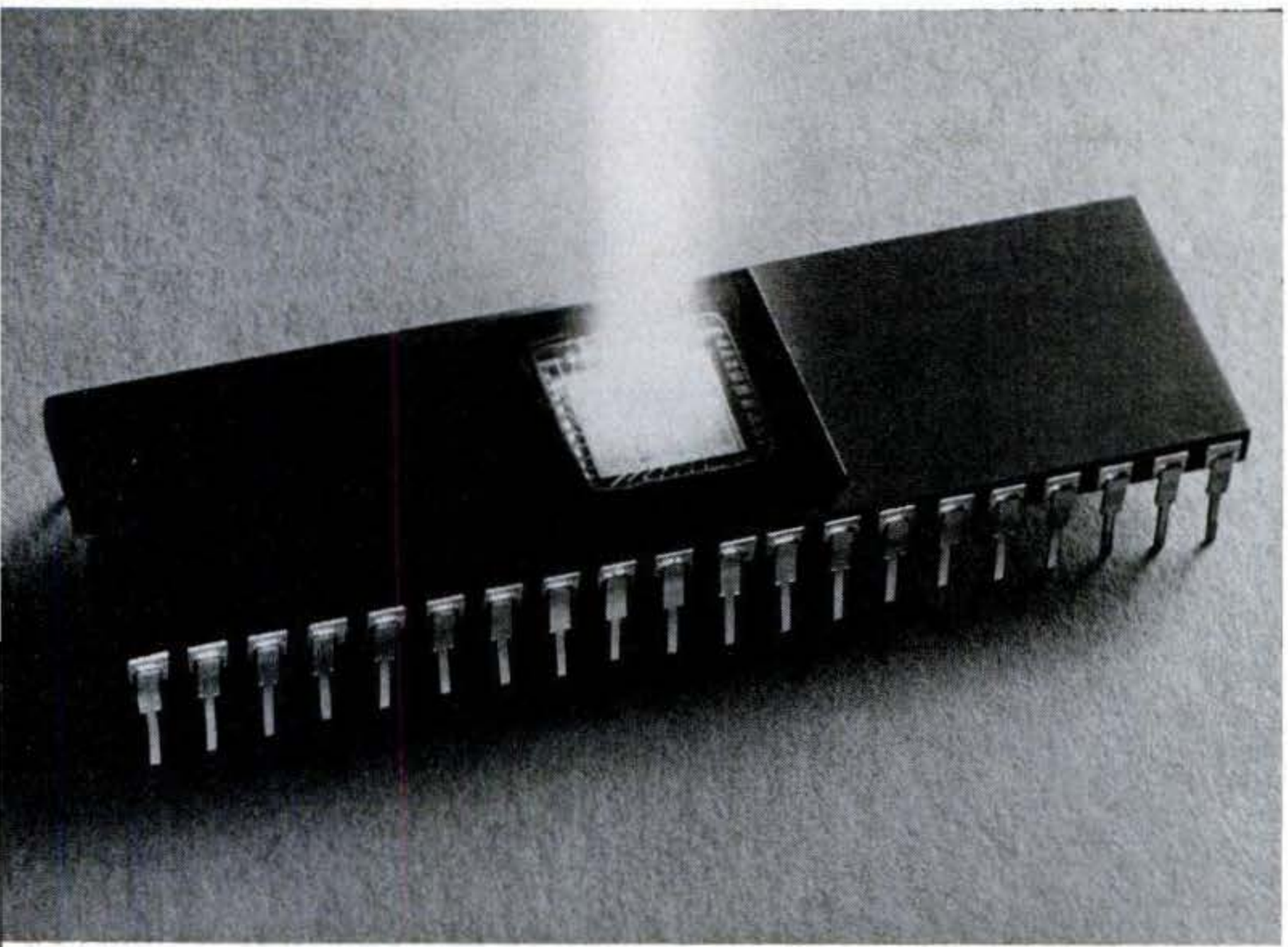
What goes on inside a microcomputer chip



An ultraviolet beam focused on a new single-chip microcomputer from Intel Corp., the 8748, erases one of its memory circuits in minutes. This permits reprogramming of the chip for different tasks. The diagram on the right represents functional areas of an 8748 and a similar chip, the 8048. Two to 10 separate chip packages are used for most microcomputers.

Digital computing relies on the manipulation of "bits" of data or electrical pulses. This is accomplished by turning microscopic transistor circuits on and off in millionths of a second (billionths of a second in larger, faster computers). "Bit" is the abbreviation for binary digit; two digits, 0 and 1, are used in the binary numbering system. Bits are organized into 'words" to represent alphabetic, numeric, and other information. In a four-bit system, for example, the decimal number 1 is represented by 0001, while 0101 represents the decimal five. Electronic games, appliances, and cash registers can use microcomputers that manipulate four-bit words. Chips that handle eight-bit words (called bytes) are suitable for more complex tasks (automotive, educational, home-control systems, "smart" instruments); 16-bit or higher word lengths serve still more sophisticated systems (data acquisition, navigation, digital filtering).

The heart of the eight-bit 8048 diagrammed is the **central-processing unit** (CPU) at **1**. This section, the microprocessor for this microcomputer, has three main sections—arithmetic, control, and logic—that perform computations and 'direct traffic" on the input and output data. The **peripheral section** at **2** has a clock circuit that times and coordinates data flow, plus special auxiliary circuits. The **memory section** at **3** has two types of memories: a read-only memory (ROM), which contains permanently stored data in the 8048 (alterable in the 8748), and a random-access memory (RAM), where data can be modified as the computer operates. The ROM stores 1 kilobyte (8192 bits), and the RAM holds 64 bytes. **Input/output** circuits at **4** are "ports" to keyboards, printers, and displays. Expansion circuitry at **5** enables users to extend the capabilities of the single-chip microcomputer.

GM research engineer William Fleming cites an analysis of 63 proposed auto systems; 56 percent of them were blocked because of unsuitable transducers. "In typical control-system applications," says Fleming, "some five to 10 transducers might be required, while the total allowable cost might range from $20 to $50. Thus, when used in automotive systems, transducers could cost $2 to $10 each."

GM researchers, and scientists and engineers at other companies, are laboring to perfect the hardware and circuits needed to supply the gargantuan appetites that microprocessors have for data. Last year, a team of GM engineers announced a tricky new circuit that may solve a lot of problems. The circuit, already shrunken onto a 23-transistor chip, puts out a pulse whose duration is proportional to the parameter being monitored.

"With this circuit, simple and rugged sensors—such as an ordinary variable capacitor—can be employed instead of more complex sensors that are less dependable," says Paul Rabe, one team member. "Since the pulsed output of the circuit is in effect a digital signal," he adds, "the signal can be fed directly to a standard indicator gauge or to a microprocessor without the need for an analog-to-digital converter."

The use of microcomputers to control fuel economy and emissions will get first priority as the match-head-size chips go into cars. But by the early 1980's competition in Detroit and from overseas may generate a race among manufacturers to top each others' computer-based functions.

Endless possibilities

Navigation devices might tell you where you're located during a journey; an alcohol-detection system could reduce incidents of drunken driving. "A microprocessor can be interposed between the driver and the engine to force better driving habits," says Gerald Herzog, an engineer at RCA Laboratories. Fuel-economy modes could be varied and selected by the driver.

"In the future," says W. A. Clapp, another RCA engineer, "microprocessors will be used more as systems components. They will be the building blocks—instead of the integrated circuits found in the catalogs we use today." Clapp foresees a tenfold jump in chip density, putting 50,000 to 100,000 transistors on a single chip. PS

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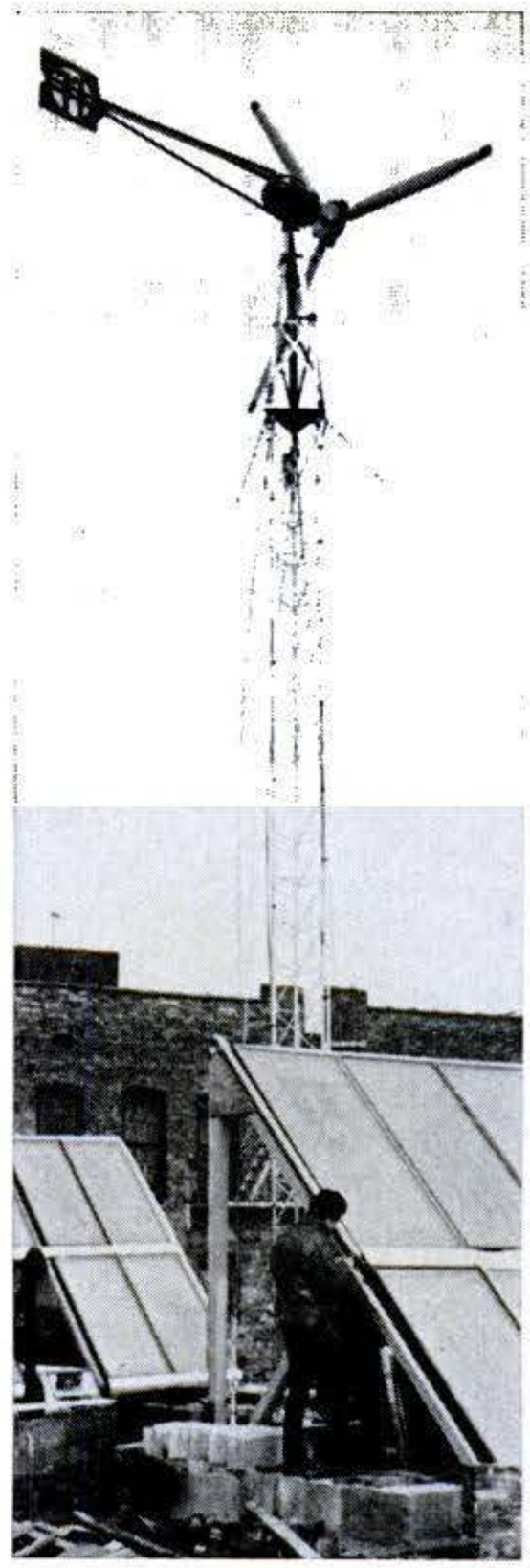
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Folding-door Ford

Gull-wing doors on Ford's far-out Corrida fold midway so no extra width is needed. The 2+2 experimental coupe, built by Ford Ghia Operations in Italy, has a chunky tailgate that drops down to extend luggage space. Power is from a 53- or 70-hp transverse engine.

Urban energy

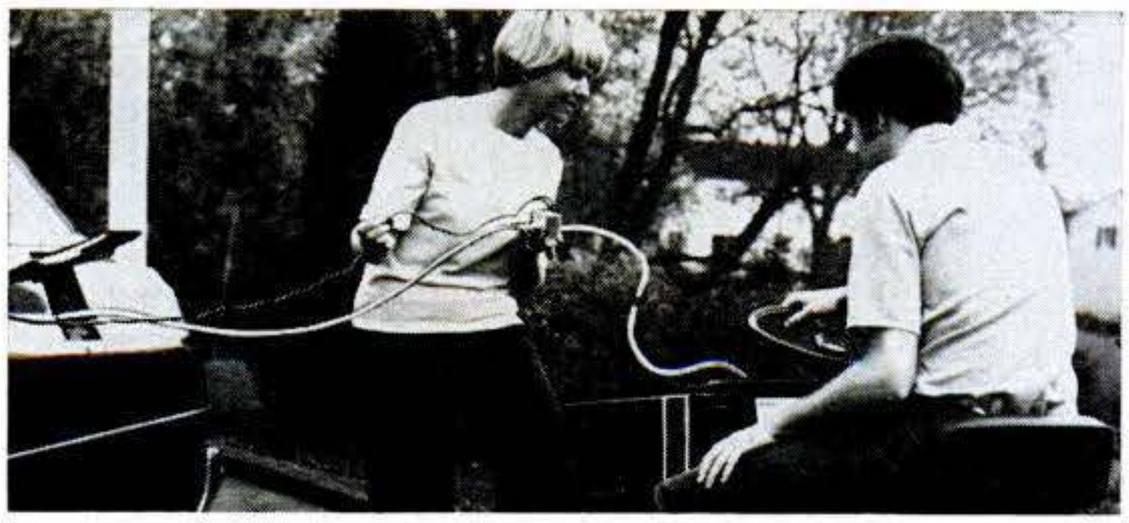
A wind-powered, 2000-watt generator and solar collectors atop a New York tenement are saving energy costs for residents. The generator, producing 75 to 200 kwh a month, provides some lighting and drives pumps. Eighty percent of the building's water is solar-heated.

Truck radial

After logging 104,860 miles in a highway test, Goodyear's new Unisteel II radial truck tire still provides a tread reading. The radial, with beefed-up shoulders, extends tread life by 25 percent over their previous radials, says Goodyear.

Bike lock

No bent bike spokes or buckled wheels with this lock —the Tosler Locrac is a wall fixture that secures and supports a bike. A hinged arm clamps on handlebars and is padlocked. Tosler (Components), 26 Mill St., Bedford MK40 3HD, England.



Electric pump

Plug Handi-Pump into a car's cigarette lighter to pump gas into yard equipment, boats, snowmobiles, camp stoves, or lanterns. Included with the electric pump is an 18-ft. cord and 10-ft. hose. It's $19.95. Facet Enterprises, Inc., Dept. M., Elmira, N.Y. 14903.

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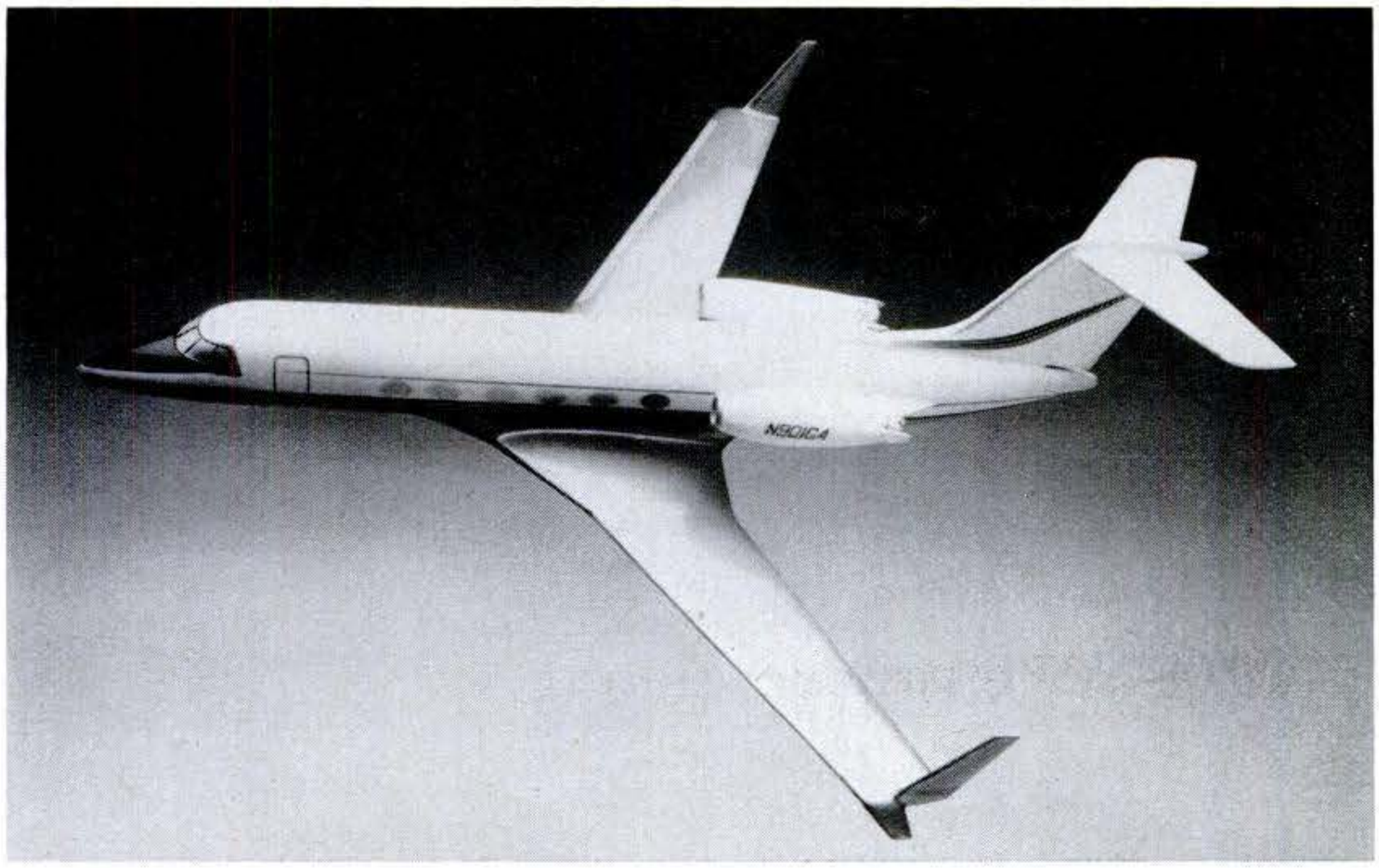
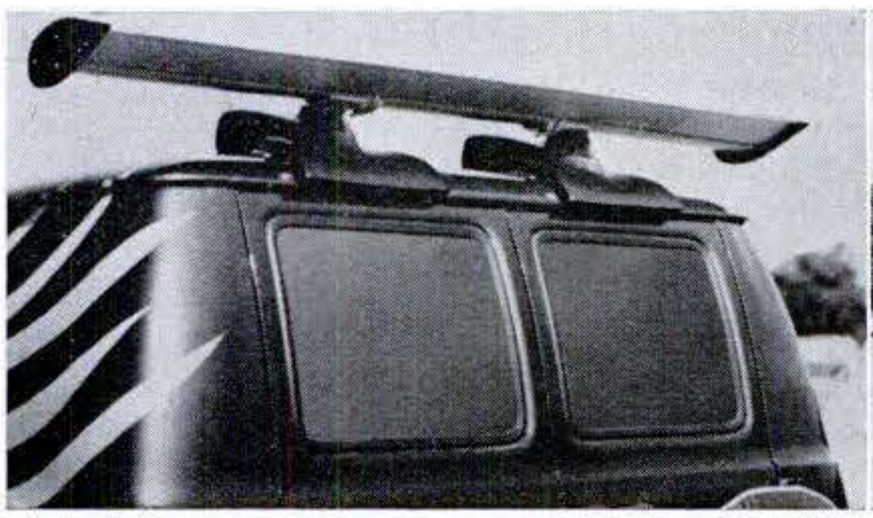


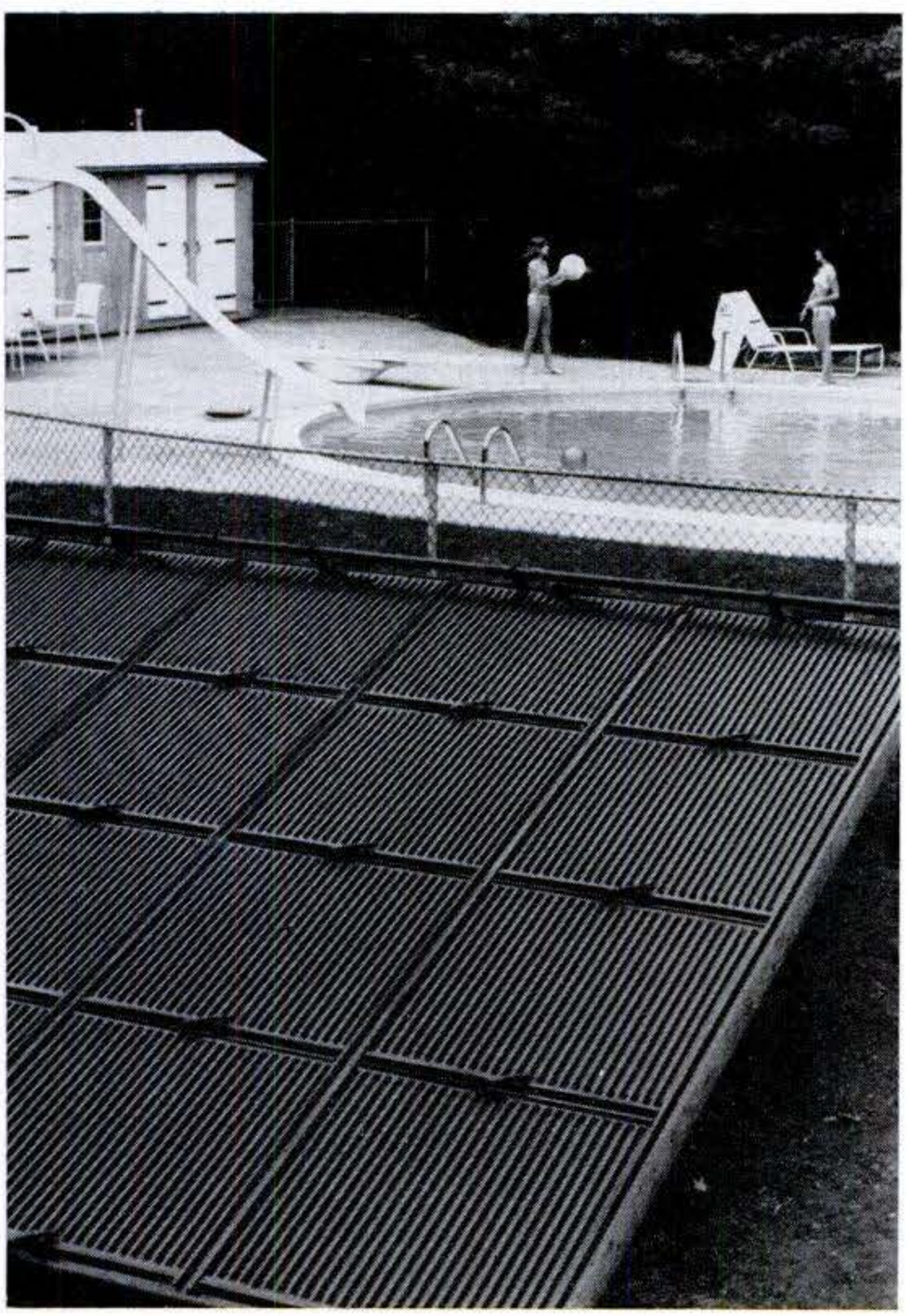
Winglets boost jet's range

Winglets—short, slanted projections on wing tips—will improve fuel consumption and increase range about five percent on this proposed Grumman Gulfstream II, it's claimed by the developer. Winglets interact with air vortices that normally spin off plane wingtips to provide increased forward thrust. The business jet would also have supercritical wings with flattened tops to reduce drag. The improved wings, plus new turbofan Rolls-Royce engines, could supply an extended range of 4000 nautical miles and a 555-mph cruising speed.



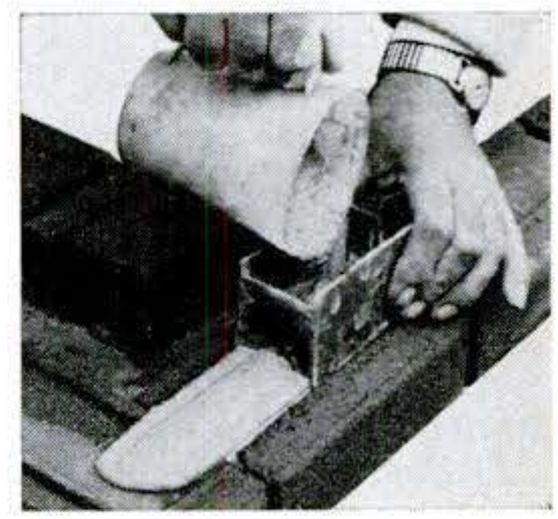
Spoiler awning

Unlatch this air-foil van accessory and a spring-loaded six-by-seven-ft. canopy rolls out for shelter. The spoiler aids handling, says the maker. It's about $200. Carefree of Colorado, 2760 Industrial Lane, Box 664, Broomfield, Colo. 80020.



Cooler chest

Flip over the Sun Packer's flat lid and you've got a holder for cups, cans, and utensils. The 11-quart, urethane-insulated cooler, from the Thermos Div. of King-Seeley, has a bail handle that locks the lid into position.



High-speed bricks

Pour mortar into this box and you can set the molded concrete bricks quickly and easily. The mortar flows into vertical cross joints and forms a horizontal strip for the next layer. Briklap Ltd., Swaythling Rd., Southampton, England.

Fuel saver: solar pool heater

Adding this new solar-heating system to swimming pools can extend the annual swim season and trim fuel costs, says Alcoa. System components, produced by H.C. Products, an Alcoa subsidiary, include black-plastic collectors, valves, piping, and either a manual or automatic control system. Electronic controls compare temperature of the pool water with that of the solar collectors. The controls determine when water is to be pumped through the collectors for heating.

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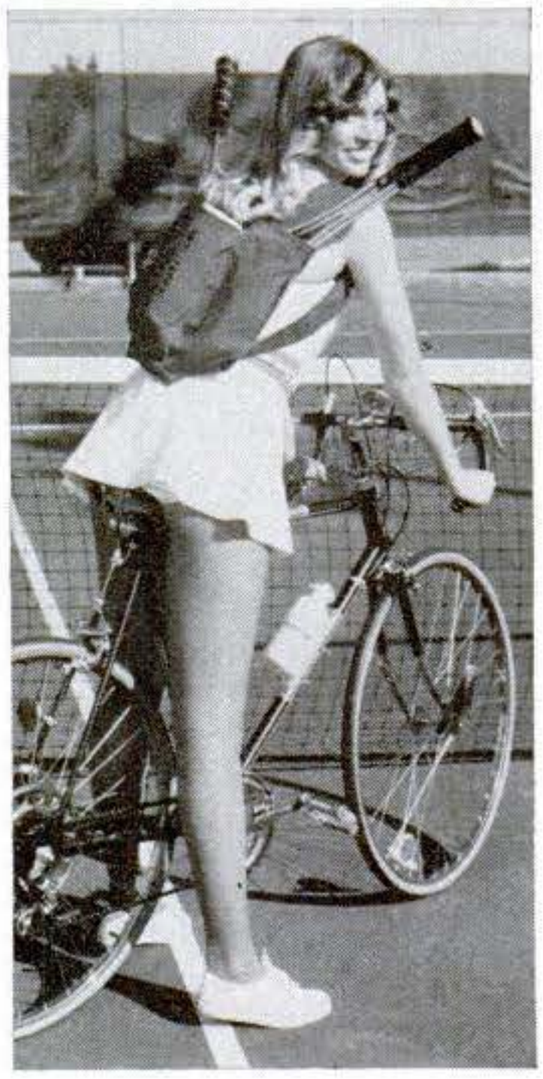
What's New

Skiing epaulets

Clever E-Straps let you stow goggles, hat, and gloves when you're at the ski lodge or on the chairlift. The Velcro-fastened straps lie flat when not holding equipment. Straps (in any color) are $5 from Kallman Products, 2030 Haring St., Brooklyn, N.Y. 11229.

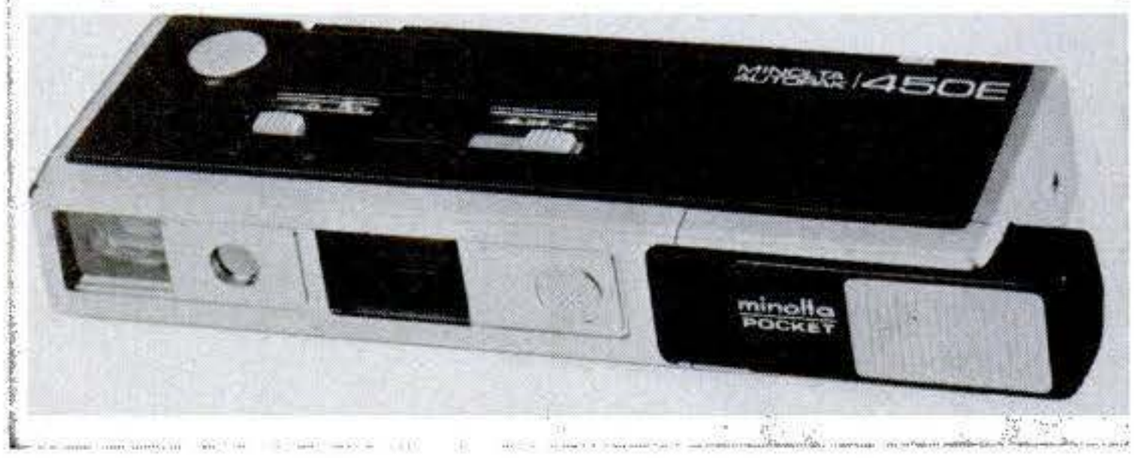
Tracking mirror

Want to test solar cells indoors? Or teach optics to a science class? The roof-mounted Model 35 heliostat automatically tracks the sun, reflecting a steady beam down into a lab. The system is $14,000 from INS/LAB, 2118 Milvia St., Berkeley, Calif. 94704.



Tennis pack

For hands-free toting, the Racquet Back Pack may be your bag. The canvas pack comes in a variety of colors. It holds two rackets, has a pocket for tennis balls. $8.99 from Tennis Innovations, 3680 Charles St., Santa Clara, Calif. 95050.



Pocket flash

A red LED on this new Minolta 110 warns you if there's not enough light for proper exposure. Slide the exposure control to the flash symbol and out pops an electronic flash. The Pocket Automatic 450E has a 26mm f/3.5 Rokkor lens with a close-up setting. $90.

Safety tire

Originally designed for the police, Goodyear's new motorcycle tire has grooved flanges that fit over the outer edges of the wheel, just above the tire beads. In case of a blowout, the flanges hang onto the wheel, holding the tire in place. Prices start at $35.

Three-wheeled, all-terrain cycle

Cowboys, stable your steeds. This chainless ATC is a trouble-free workhorse, says Commuter Industries (Box 309, Cascade, Ia. 52033). The TE-380's transaxle drive has gears with sealed bearings; an eight-hp, self-starting Kohler engine; and automatic transmission. Price: around $1150.

Auto for the disabled

A disabled person can roll a wheelchair up the drop-down rear ramp of this prototype vehicle from Britain's GKN Group. Fastened by special locks, the chair then serves as the driver's seat. The center-drive vehicle is powered by a four-cylinder, 998cc transverse engine.

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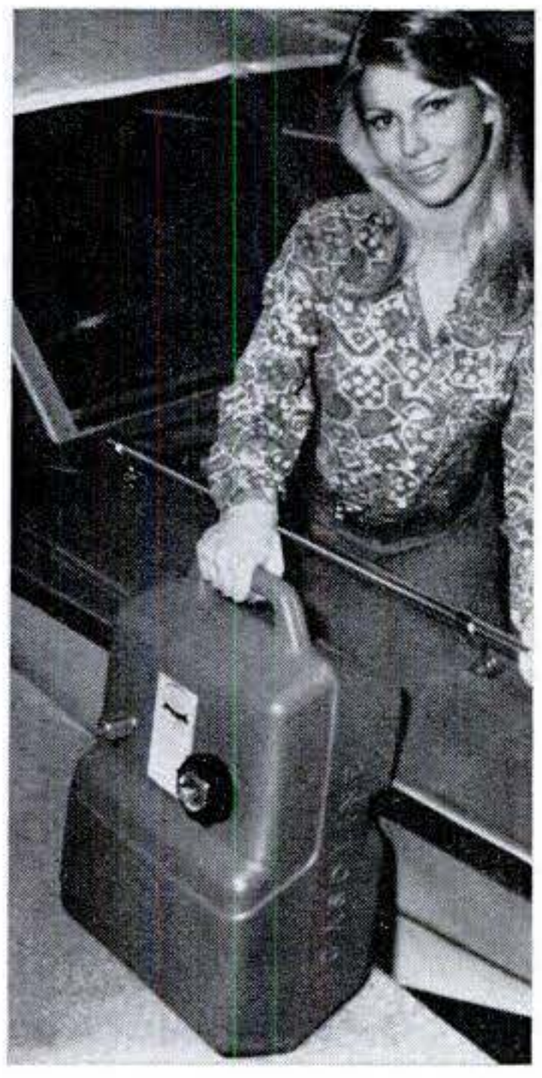
What's New IN BOATING

BY SUSAN RENNER-SMITH

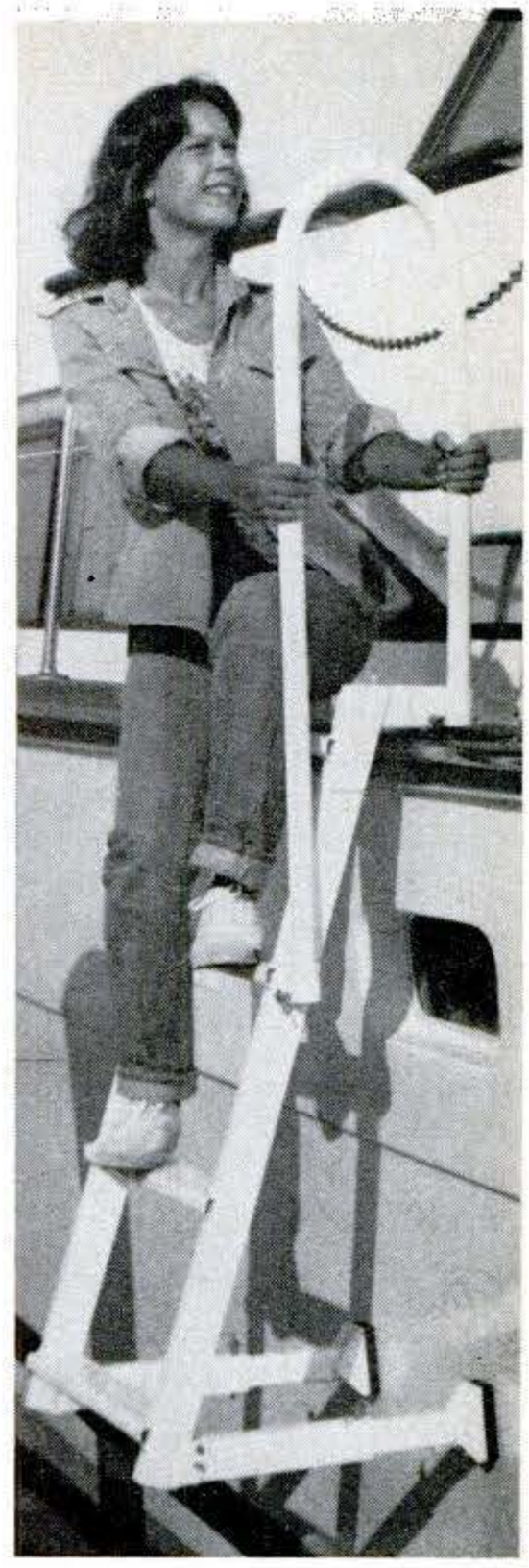


Carry-on gas tank

A space-saving, 90° withdrawal elbow connects Tempo's compact, nine-inch-high fuel tank to the fuel line. The six-gallon tank has a reserve fuel section, fuel gauge, vented gas cap. It's $22.50. Tempo Products, 6200 Cochran Rd., Cleveland, Ohio 44139.

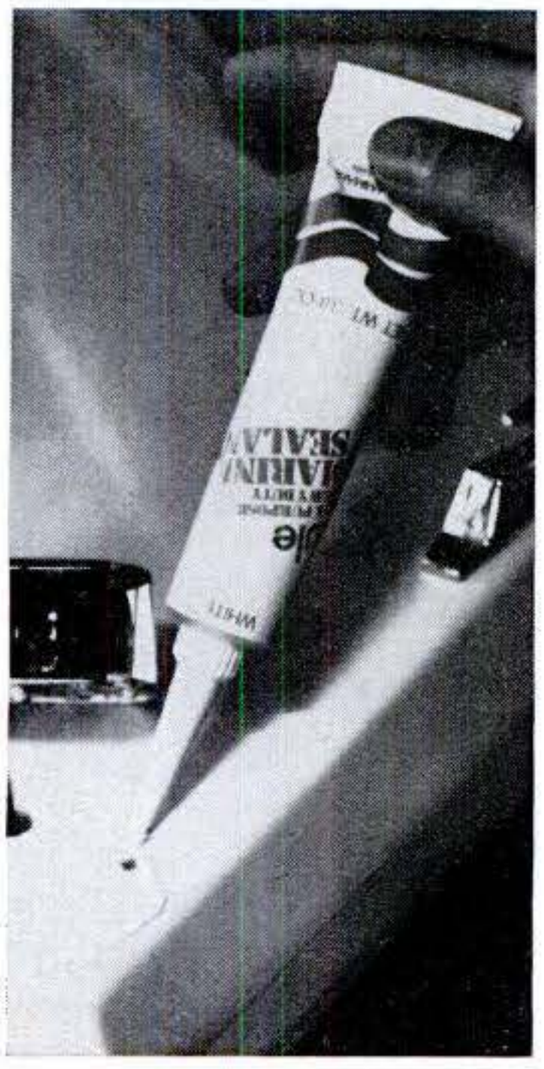
Convertible power / sail

When the wind's up, you can bolt on the sail deck of this new Hydrocat. On calm days, switch to power. It accepts any four- to 35-hp outboard. Each component bolts on in minutes and is light enough to be handled by two persons, says the maker, Stevenson Projects, P.O. Box 584, Del Mar, Calif. 92014. The twin tunnel-shaped hulls are foam-filled and have kick-up rudders for easy beaching. The two-power system is about $590; kits start at $250.



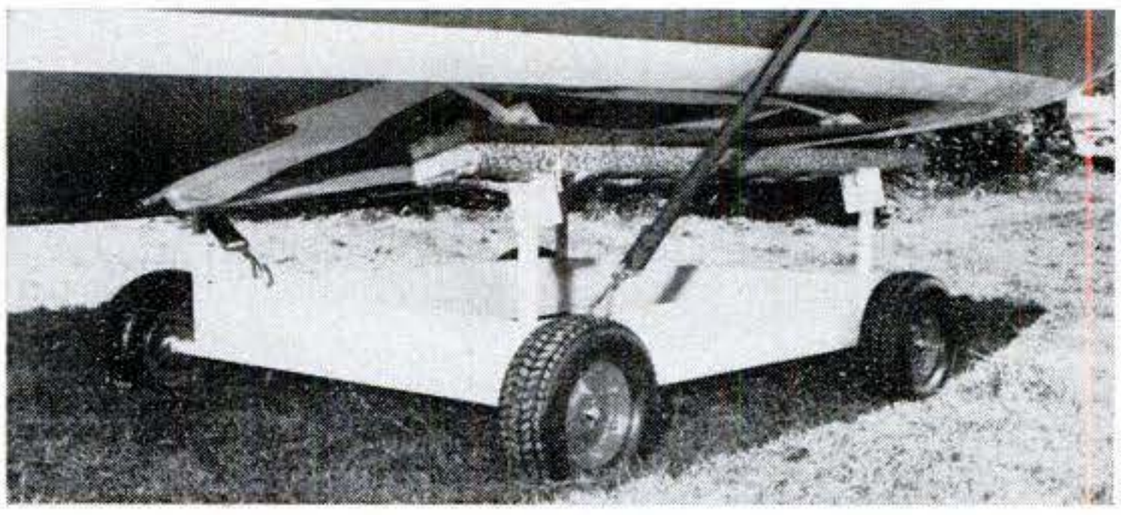
Lightweight ladder

Anyone can easily heft this 17-lb. boarding ladder, yet it supports up to 600 lb., claims Miller Industries (1525 Marion, Grand Haven, Mich. 49417). The aluminum ladder is 68 by 17 inches and has adjustable legs, nonskid feet, and a removable handrail. Price: $125.



Waterproof sealer

Saltwater, oil, or diesel fuel won't affect this new marine sealant, says Rule Industries (Cape Ann Industrial Park, Gloucester, Mass. 01930), so it can be used below the waterline. You can also use it to insulate deck hardware, such as the bow light pictured. A three-ounce tube is $3.49.



Seagoing caddy

You can wheel this caddy into the water, strap on a boat with pivoted centerboard, and push it up on the beach. The 70-pound "Kaddy" holds 600 pounds and splits into nesting halves for easy transport. Price: $89.50 from Gagne Assoc., 1080 Chenango St., Binghamton, N.Y.

Hour meter

Want to keep track of your engine's running time? The model H500 elapsed-time meter takes only two wiring connections, and mounts on any boat dash, says the maker, General Time Corp., Main St., Thomaston, Ct. 06787. The meter operates on four to 50 VDC. Price: $14.95.

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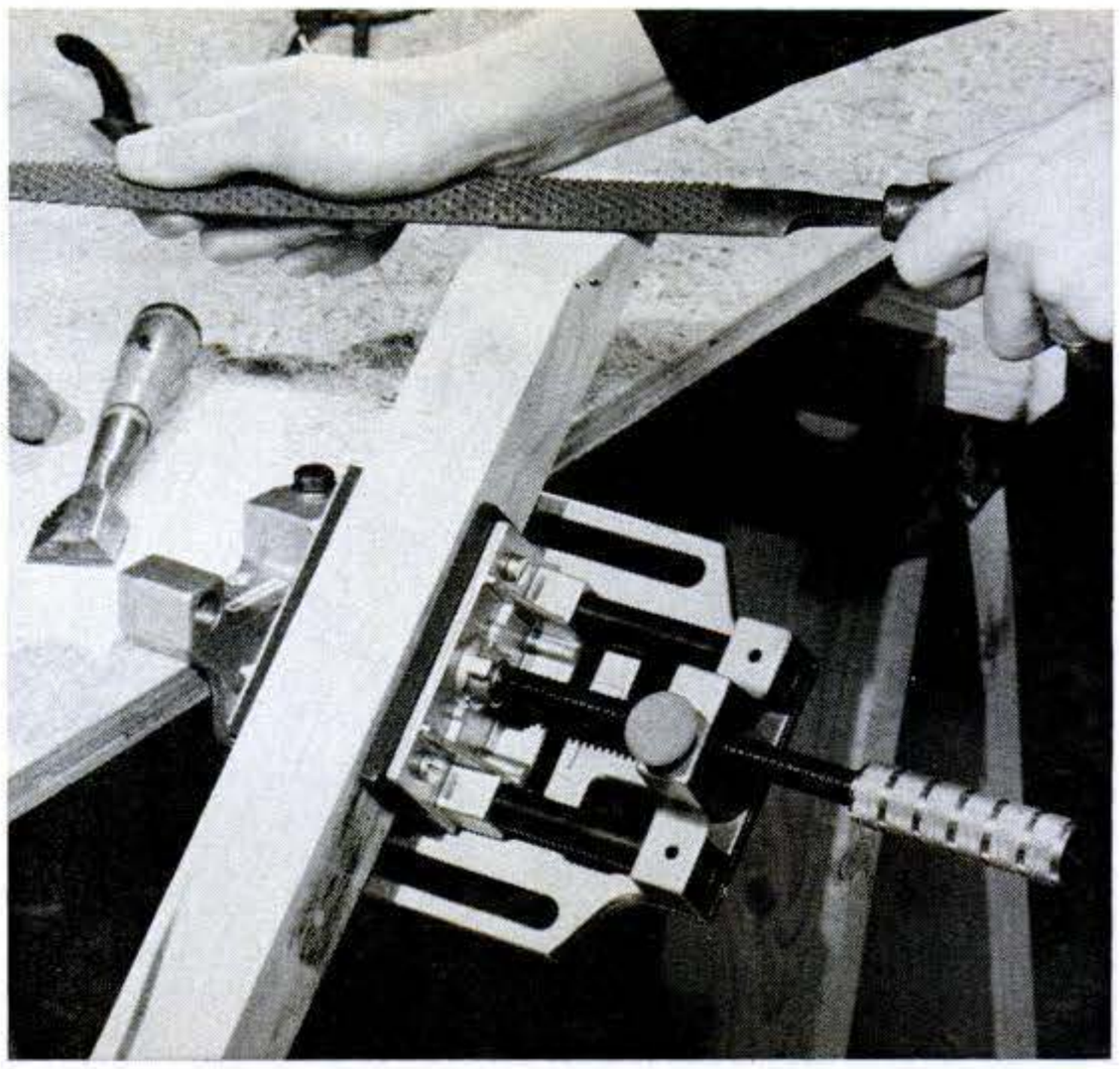
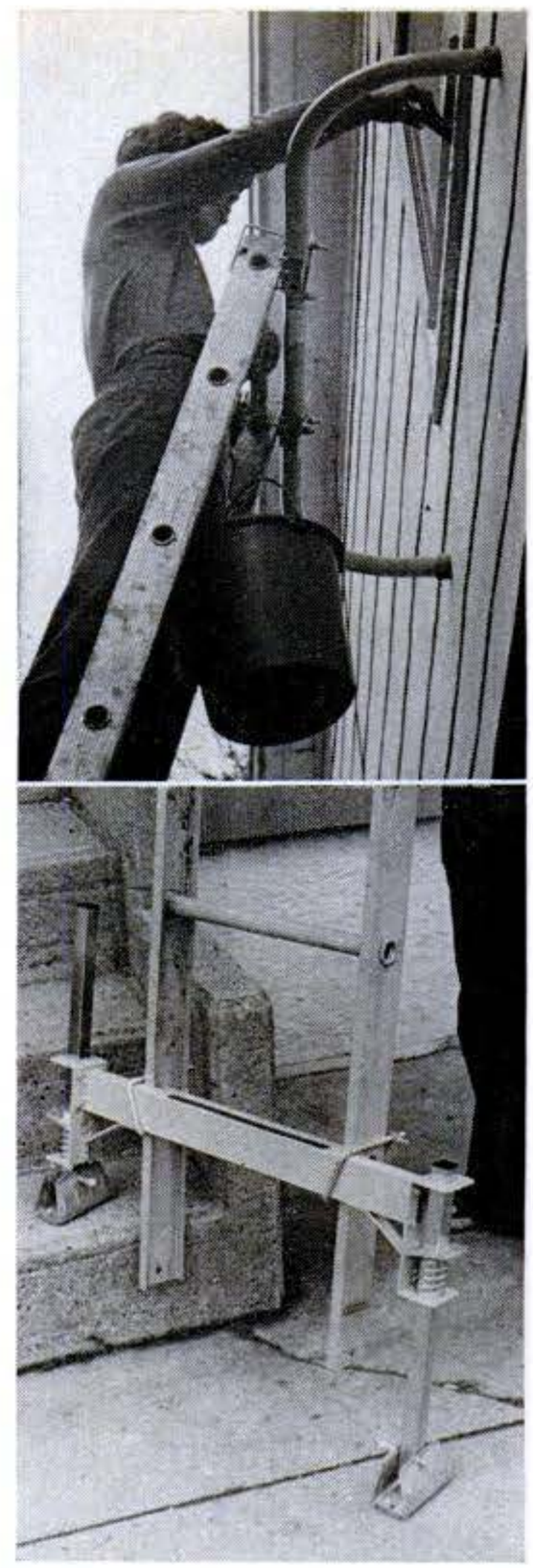
What's New IN TOOLS

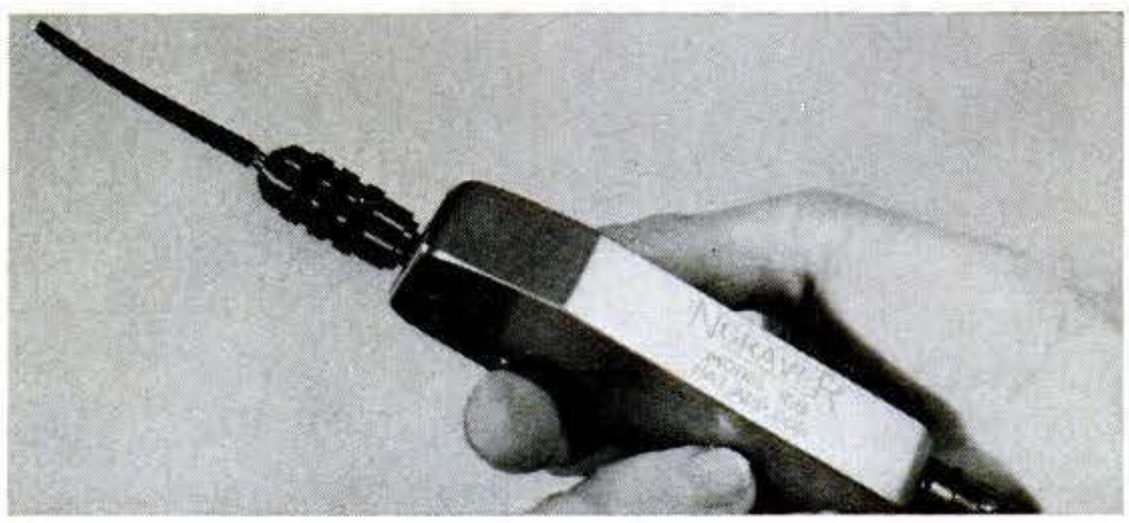
BY R. L. STEPLER



Aluminum vise

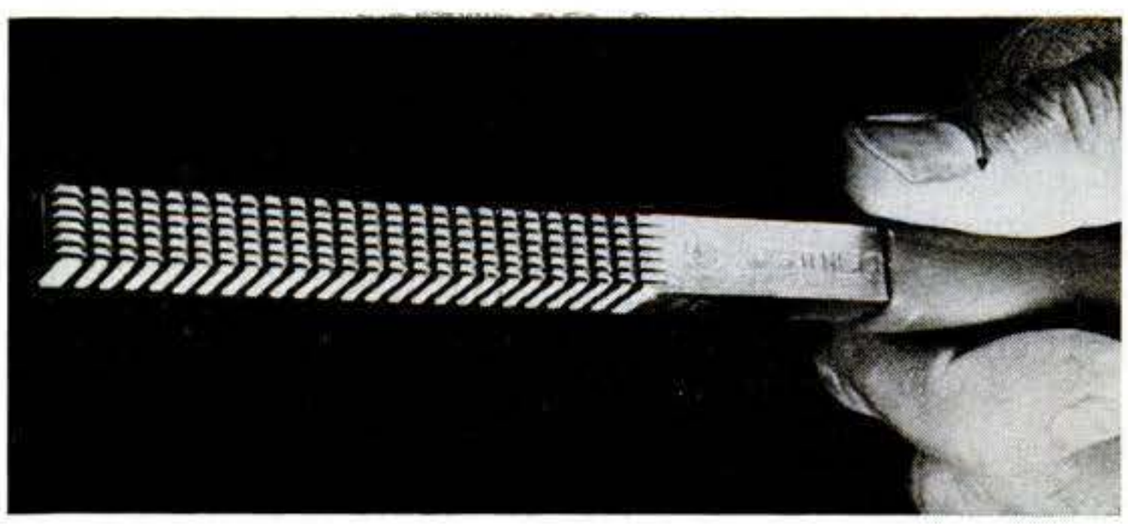
Clamped to your bench, this vise holds objects vertically, horizontally, or at 45°. You can use it with a drill press, too. Quick-release button permits fast adjustment. Coastal Abrasive & Tool (Box 337, Trumbull, Conn. 06611) sells the vise for $40.





Engraver

The model 100 miniature impact tool is controlled by a foot rheostat, variable from 300 to 1500 impacts per minute. A standard flexible-shaft machine (not included) powers it. Price is $99.50 from Ngraver Co., 879 Raymond Hill Rd., Oakdale, Conn.

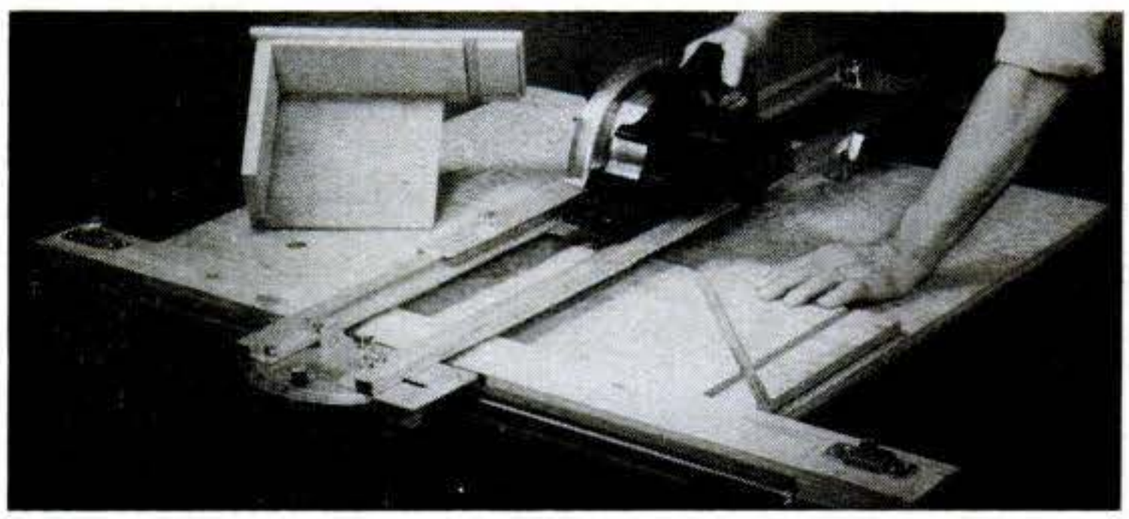


Thread file

Jawco's thread-restoring files now have a comfortable removable vinyl grip. The line of "8 in 1" Nu-Thred files recondition both English and metric threads. Jaw Mfg. Co., 39 Mulberry St., Reading, Pa. 19603, makes them.

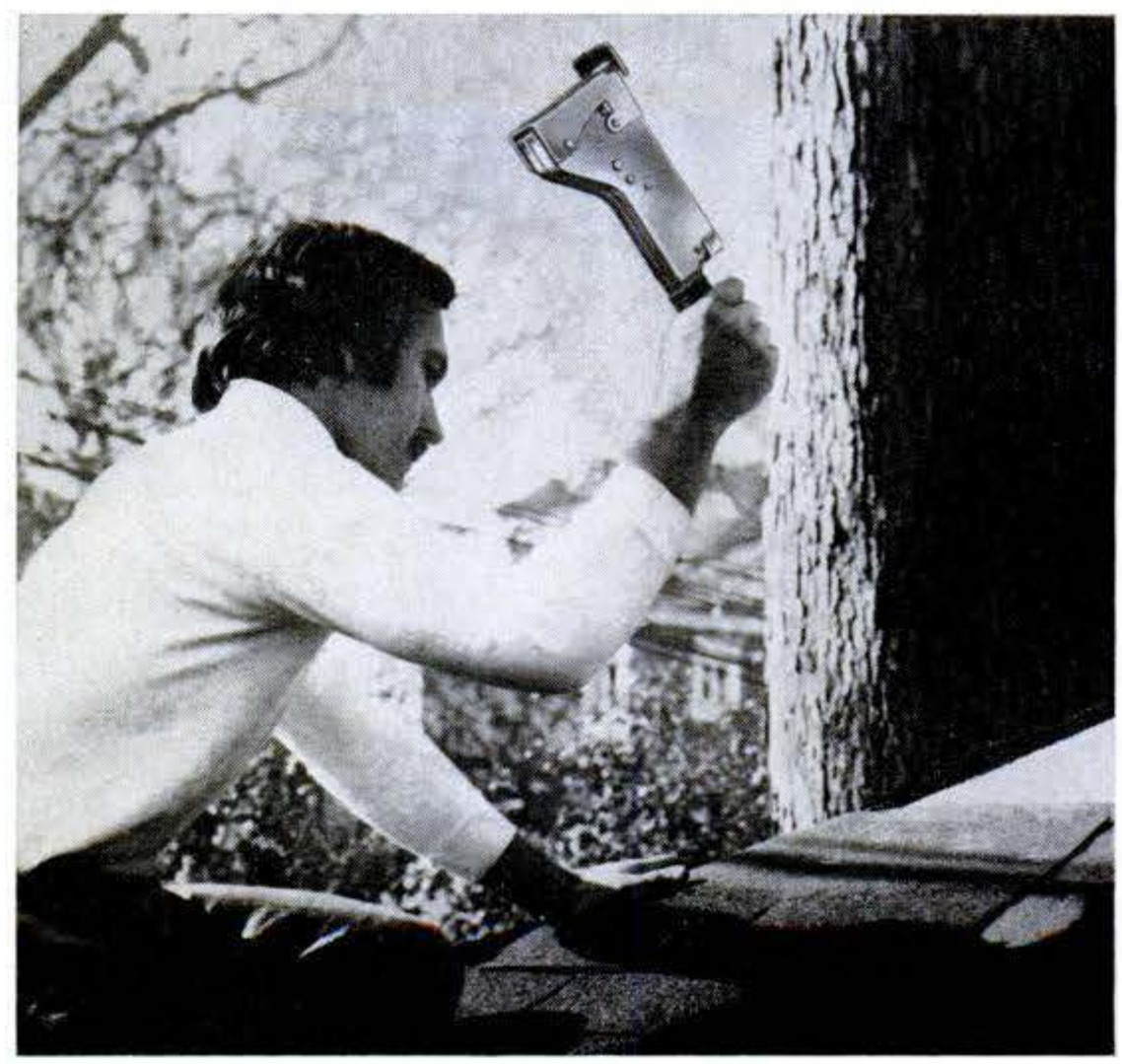
Ladder leveler

Sears' Level-izer (bottom) attaches to any extension ladder, is foot-adjusted so you keep your hands on the ladder. The heavy-duty-steel device costs less than $20. For complete safety use a stabilizer, too (top). It's $10 from Sears.



Cutting guide

You'll make more accurate cuts with circular saws, saber saws, and routers if you use Trik-Trak. It slides, tilts, and pivots to let you make flat, vertical, and compound miters, rip cuts, plus rabbets, dadoes and more. Price is $69.95 from Hauer Co., Putnam Valley, N.Y.



Hammer tacker

Arrow's model HT-65 hammer tacker packs the power to drive 1" by ¾" staples. The 4½-lb. tool is ideal for roofing, and for installing plywood subfloors, says the maker. Arrow Fastener Co., 271 Mayhill St., Saddle Brook, N.J. 07662.

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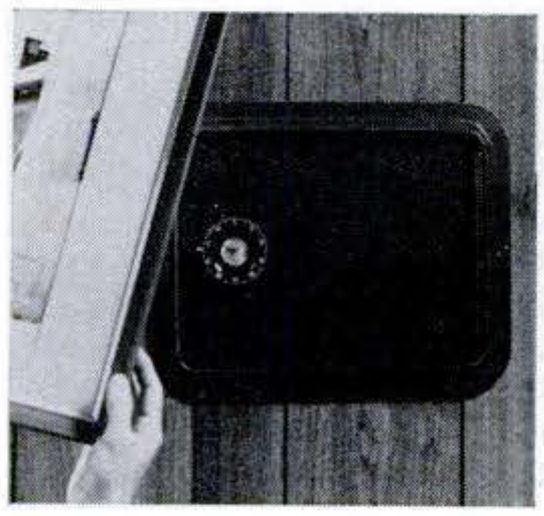
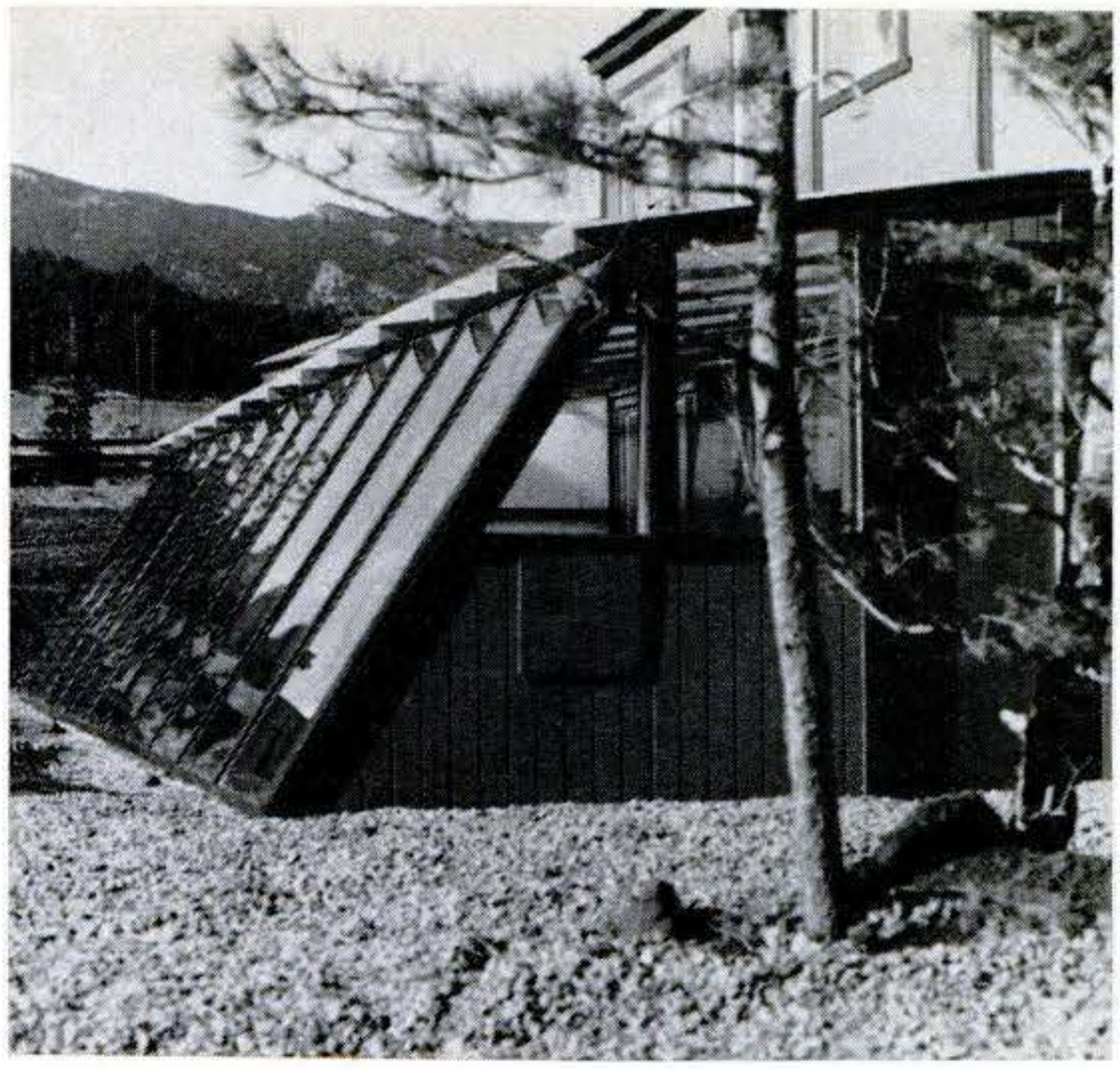
What's New IN HOME IMPROVEMENT

BY R. L. STEPLER



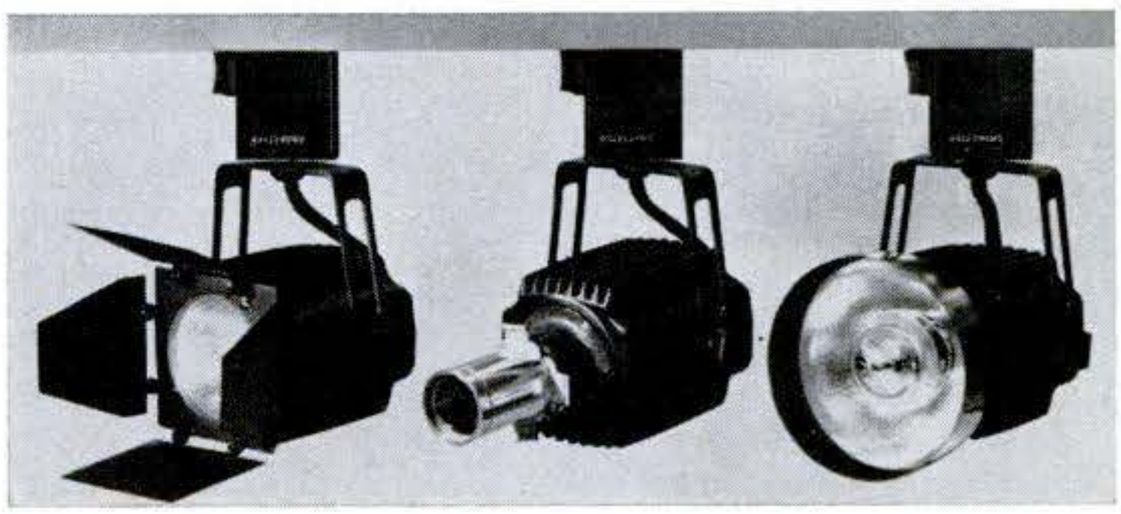
Wall safe

You can install this safe yourself using ordinary household tools, says Sears. It measures 10½-by-14-by-3⅝ in. to fit most interior walls. Recessed door is ¼"-thick steel. Capacity is 430 cu. in. Price: $57.95.



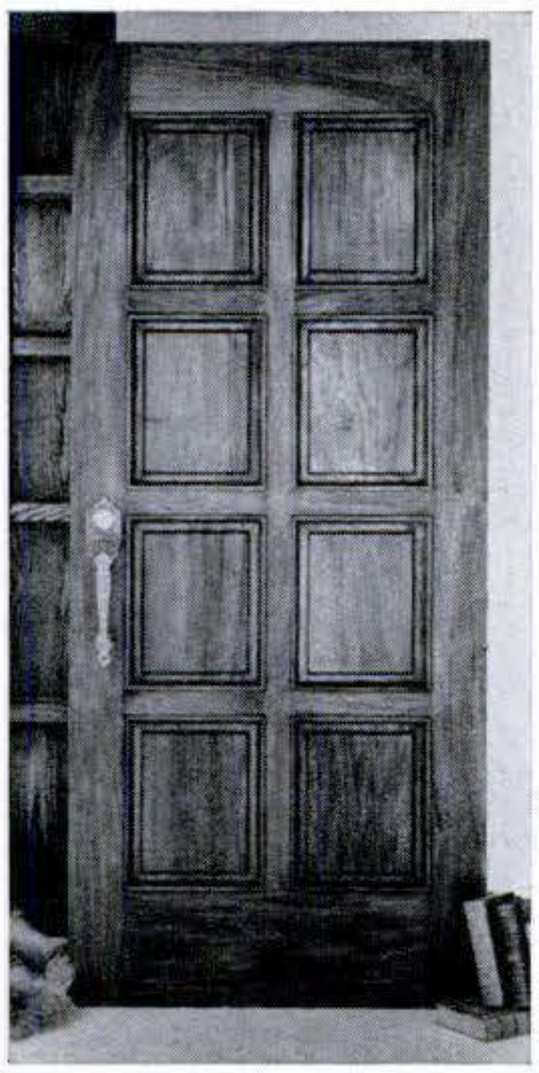
Solar-heated greenhouse

Solera, a building system of four-foot modules, can be a greenhouse, patio cover, or sauna. Fitted with Solus collectors, the structure can be partially solar-heated, and can provide supplemental heat to an adjoining house. Model shown measures 45 ft. long by 16 ft. wide; it includes grow beds, evaporative cooling, solar collectors, and thermal storage. Price: $10,000. Other models start at $800 in kit form. Solar Technology Corp., 2160 Clay St., Denver, Colo. 80211.



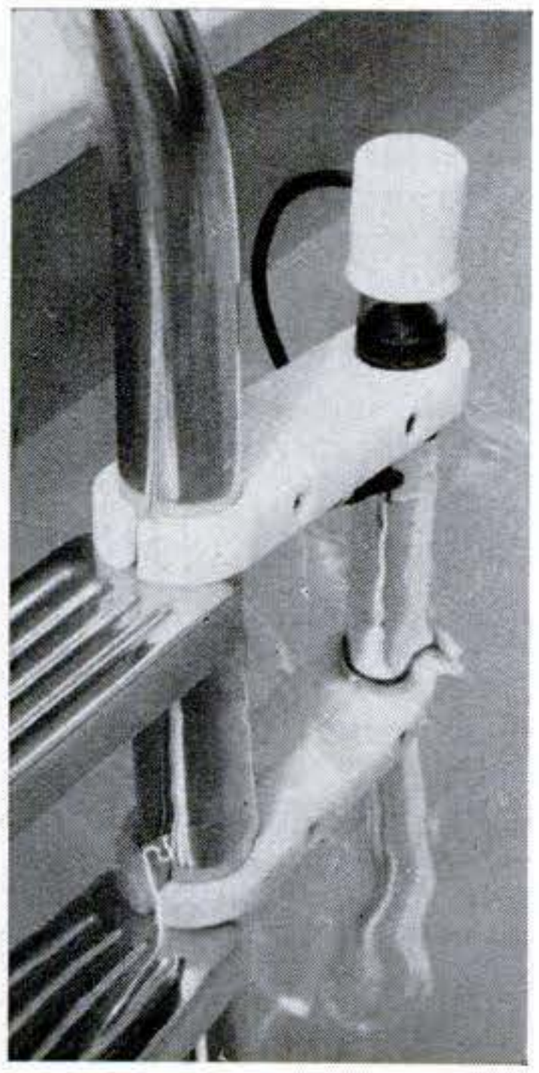
Track lights

Your living room becomes a movie set with Swivelier's Cinema Series track lights. Cinema 36 (right) has low-voltage lamps; framing projector (center) lets you spotlight a painting; Cinema Halogen 250 takes up to 250-watt tungsten-halogen lamps. Swivelier, Nanuet, N.Y.



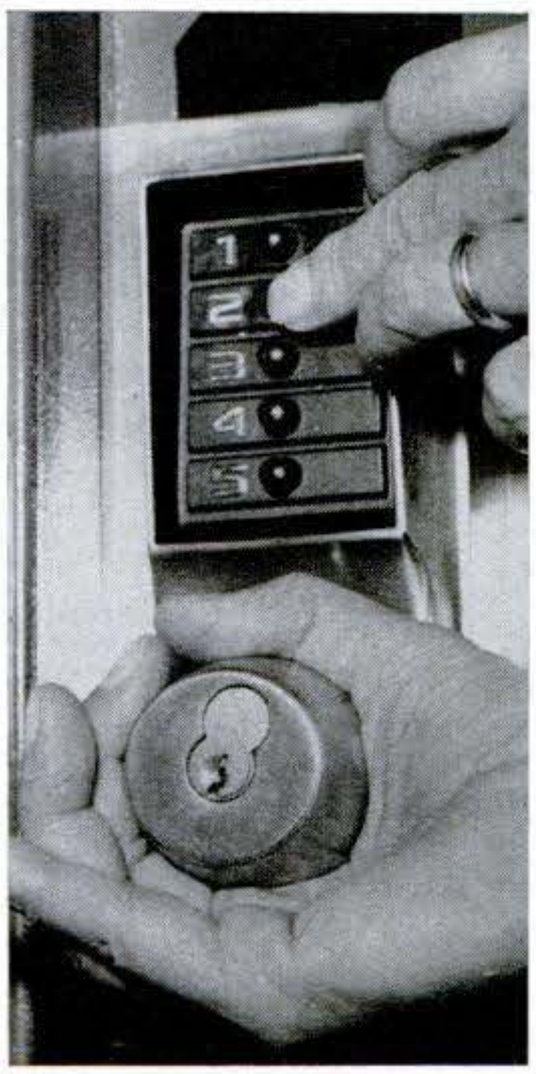
Front door

With this door gracing your entry, you'll know you've arrived. Called "10 Downing St.," it's 140 lb. of solid rosewood, hand-carved on both sides. The 3-by-6-ft.-8-in. door costs $294 (it's 1¾-in. thick). Elegant Entries (45 Water St., Worcester, Mass. 01604) makes it.



Pool light

The maker of Aqua-Luminator says it makes the entire pool glow with soft radiance. The two-ft. tube, with four low-voltage lamps, clamps to a pool ladder, runs on batteries or transformer. Price is $75 from P.B.S. Co., Box 426, Toms River, N.J. 08753.



Push-button lock

Five buttons in the proper sequence opens this lock. Forget the sequence? Use an optional key. The Series 1000 Lock has a ¾" antifriction deadlocking latch. Price: $150. Unican Security Systems, 400 Fawn Dr., Rocky Mount, N.C.

Damper

This damper goes on top of a chimney to seal out rain and birds, and reduces heat loss. A silicone adhesive/sealant holds it in place. You shut it with a cable that runs down the flue. Lyemance International, 143 Breckinridge, Louisville, Ky. 40208.

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What's New IN ELECTRONICS

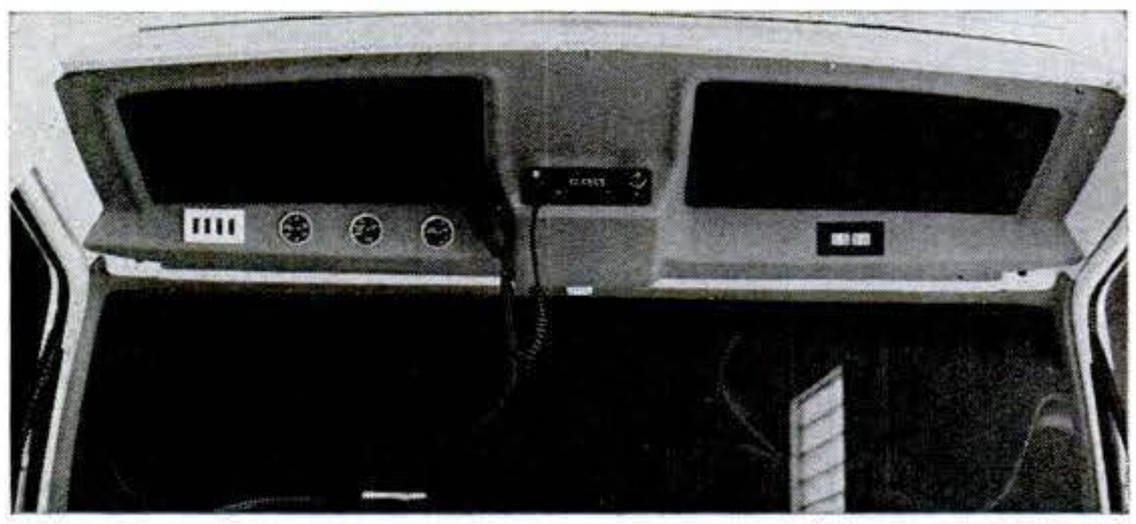
BY WILLIAM J. HAWKINS

Slide in, voice out—new learning tool

Slide the learning card through this Sony Sound Maker and the student hears a sentence or musical phrase related to what he sees. The sound comes from a magnetic tape strip on the bottom of the laminated card that he inserts in the top of the player. First demonstrated at a recent Japanese Electric Show, the system, including five cards, will sell for approximately $100 in the U.S. A package of 120 cards will cost about $50 from Sony.

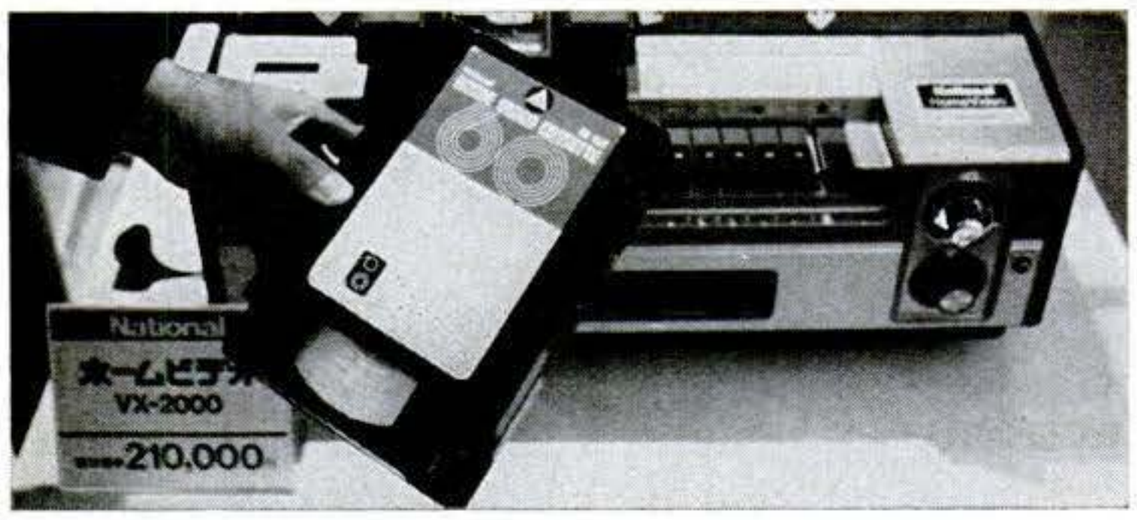
Printing calculator

Punch up $100 on this Unitrex keyboard—that's the price of the eight-digit 9HMDP model with digital display and printer. Hit the "P" button and calculations are printed on paper as well as displayed. Unitrex of America, 689 5th Ave., New York, NY 10022.



Headliner CB mount

Add this Consoliner to the roof of your van and you've provided for CB, tape, gauges, clocks—whatever. It replaces part of the factory-installed headliner. $89.95 from Plastic Products., 2800 John Daly Rd., Inkster, Mich. 48141.



Home videotape

Pop in this video cassette and watch up to 100 minutes of prerecorded movies on the new VX-2000 videotape recorder from Panasonic. Blank cassettes are available. Expected price for the machine when it's introduced next month is $700.

Programmable tape deck

What selections would you like to hear on a particular tape? Tell this cassette recorder and it will automatically play them—in the order you'd like. The RT-3535 programmable Optonica deck is made by Sharp. Price: $429.95.

Digital CB tester

Attach this CB monitor between your CB rig and its antenna and you'll get a digital readout of frequency, wattage power, and SWR. The Monitor 38 works off house current or 12 VDC. Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio 44108.

Do-it-all recorder

Tape counter, cue control, one-touch record, pause, ALC, auto shutoff—all features you'd expect from a $100 hand-held cassette machine. Right, but you get them for only $50 in this new Bigston PL-200. It uses standard cassettes.

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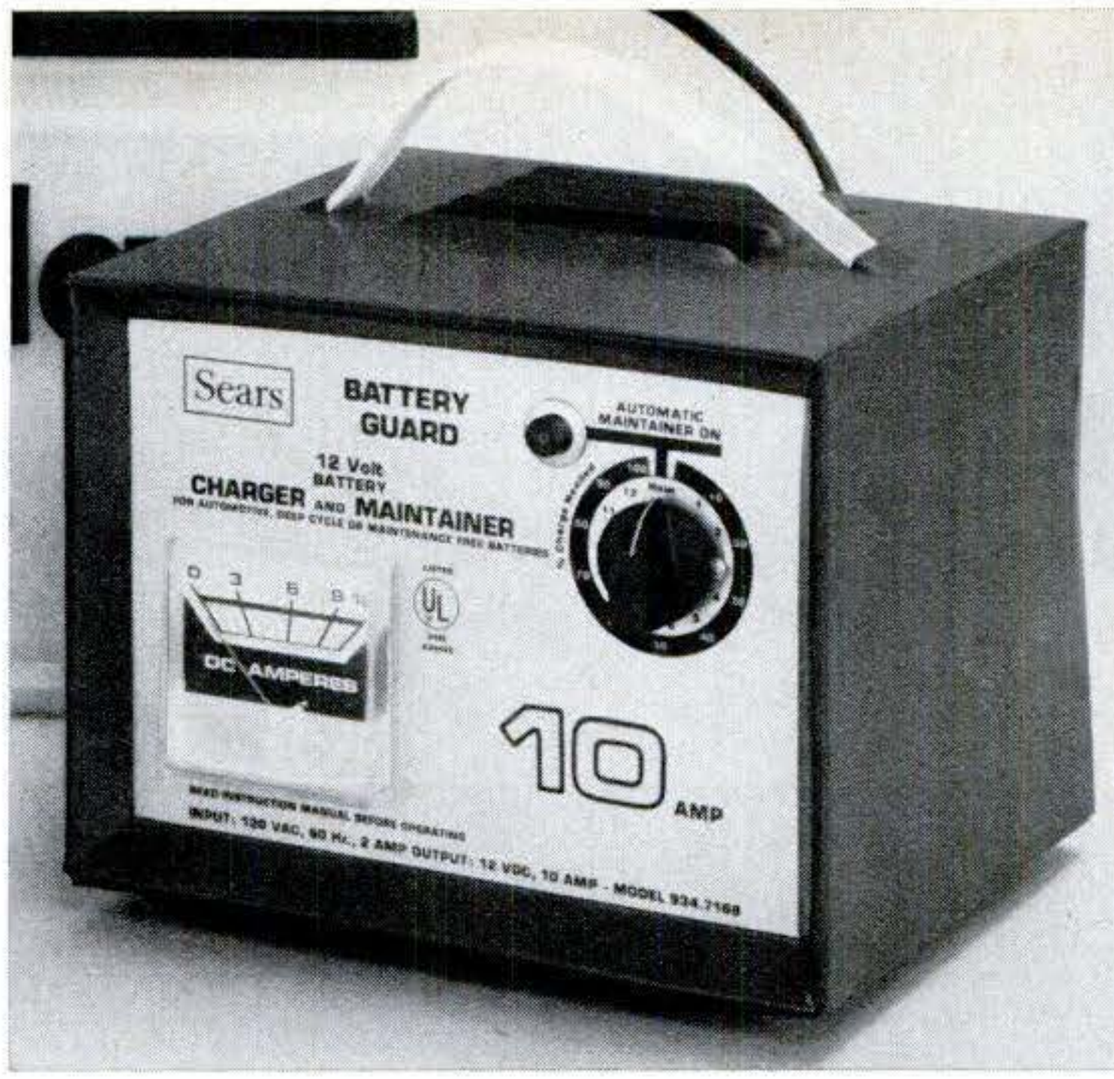
What's New
FOR YOUR CAR

BY RAY HILL



Versatile charger for batteries

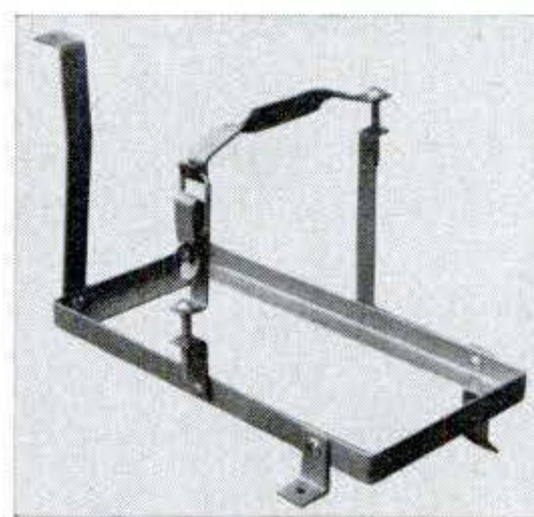
You can revive a run-down battery with this charger or keep a normal battery fully charged and ready to go if your car will be sitting idle for a long time. When the charging cycle is complete, Battery Guard automatically switches to a maintaining condition—keeping your battery in a full state of charge. It's ideal, says the maker, for maintenance-free, deep-cycle cells used to power trolling motors and electric delivery vehicles. It can be used only with 12-volt batteries. Sears sells it for $49.95.

Vacuum checker

Want a quick, painless way to determine whether your choke pull-off or vacuum advance is working? Press a bulb on Vacu Chek; if the bulb pops back, the line is leaking. Thexton Mfg. Co., 7685 Parklawn Ave., Minneapolis, Minn. 55435.

Oil dispenser

No spills or waste when you use Trig-a-Flow, says the maker. You insert the oil can and pull the trigger; the device punctures the can, allowing oil to flow. There's a flexible extension for hard-to-reach places. It's $3.74 from Better Automotive Products, 520 Fifth Ave., NYC 10036.



Battery holder

Here's a heavy-duty battery carrier for 1973 and newer Chevy and GMC ½-, ¾-, and one-ton trucks. It holds all popular truck-battery sizes, can be padlocked to deter theft, and is corrosion-resistant. Price: $15.95. Paktron Products Co., 20201 Prairie St., Chatsworth, Calif.

Ignition wire

Heat-resistant, silicone-jacketed ignition wires work even when under-hood temperatures soar to 350°, says Belden of its Power Path 7mm wires for cars and vans. Belden Corp., 2000 S. Batavia Ave., Geneva, Ill. 60134.

Emergency flashers

If your car is disabled and you can't get it off the road, the twin flashers in this fluorescent orange "day-glow" case warn drivers a mile down the road in either direction, says the maker. A 25-ft. cord attaches to the cigarette lighter, allowing you to signal for help while remaining in your car. Also included in the kit: eight-ft. jumper cables, a tire inflator for up to 25-psi of pressure, a six-ft. gas-siphon pump, flashlight, gloves, tire gauge, first-aid book and kit. From Carter Hall, Inc., 6 W. 32nd St., New York, N.Y. 10001. Price: $30.

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Cam-action **air motor** develops full torque at rest

By DAVID SCOTT

A novel air motor, developed by Canadian inventor George Striegl of Prescott, Ont., is entering the marketplace as a plastic, piece-together educational toy for children. But Striegl has more serious applications in mind. The clever motor has pistons but no crankshaft; it develops full torque at rest (like a steam engine), eliminating the gearbox; and it's also nonpolluting and virtually noiseless.

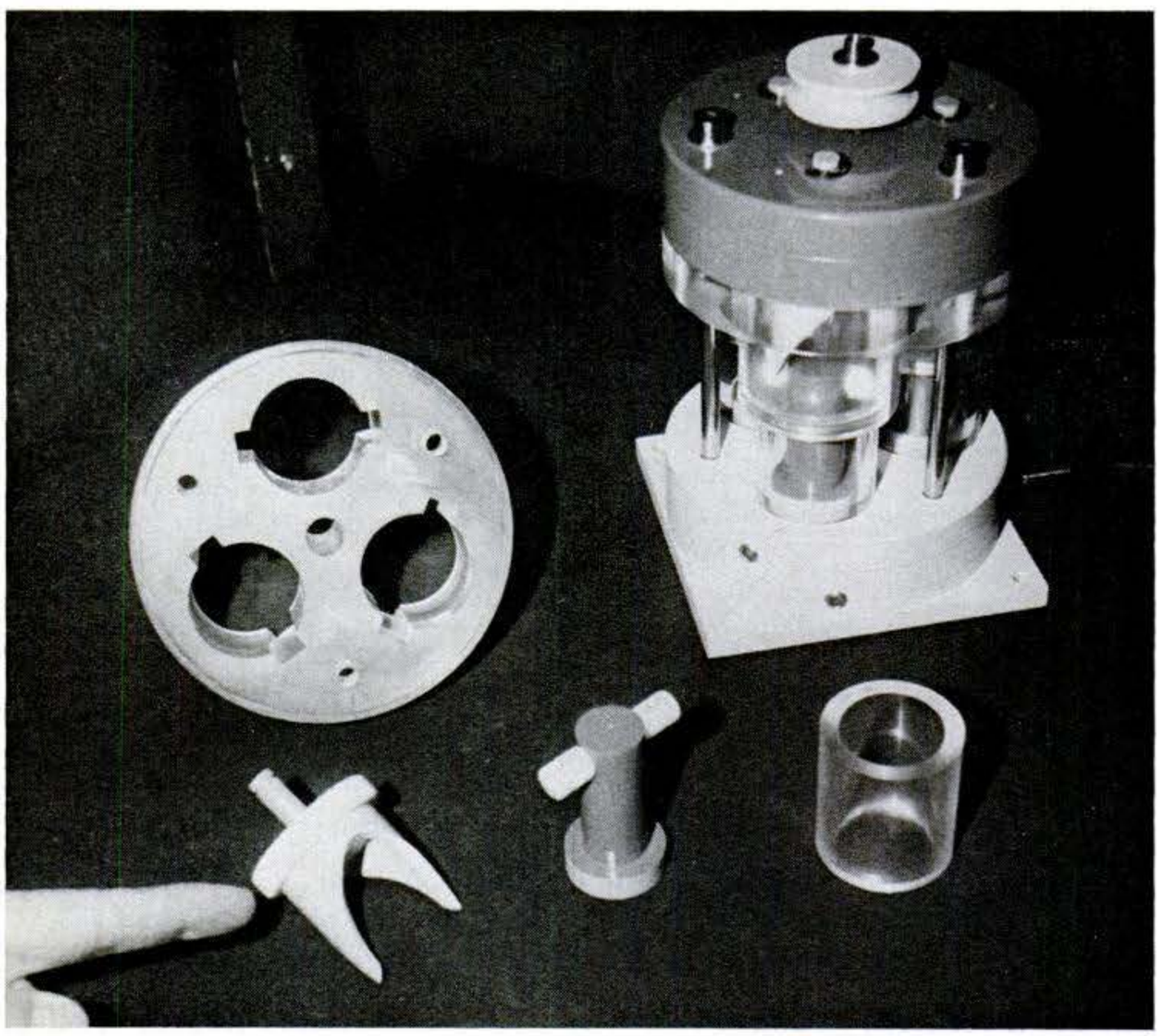
These advantages, says Striegl, make it ideal for powering indoor vehicles at airports, railroad stations, and hospitals. The range would be short, but refilling the on-board air bottles at convenient points around the building would take only seconds. (Recharging batteries for electric cars can take hours—and batteries are much heavier.) The motor would also be a natural in mines, because no potentially explosive fuel is used.

The toy version, made by Tempo Contact Ltd. (Box 40, Spencerville, Ont. KOE 1XO, Canada), is a vertical model, with three cylinders equally spaced around a central output shaft. The diagram (which is of a two-cylinder rather than a three-cylinder motor) shows how it works. In the three-cylinder model, of course, the cylinders are phased 120° apart (rather than 180° as shown in the diagram), and cycle with successive power strokes. Air inlet and exhaust are controlled by individual spool valves in the base of the motor. The valves are operated by cams at the bottom of the central shaft. Valve timing is set so compressed air is injected only during the first third of each piston's upward stroke.

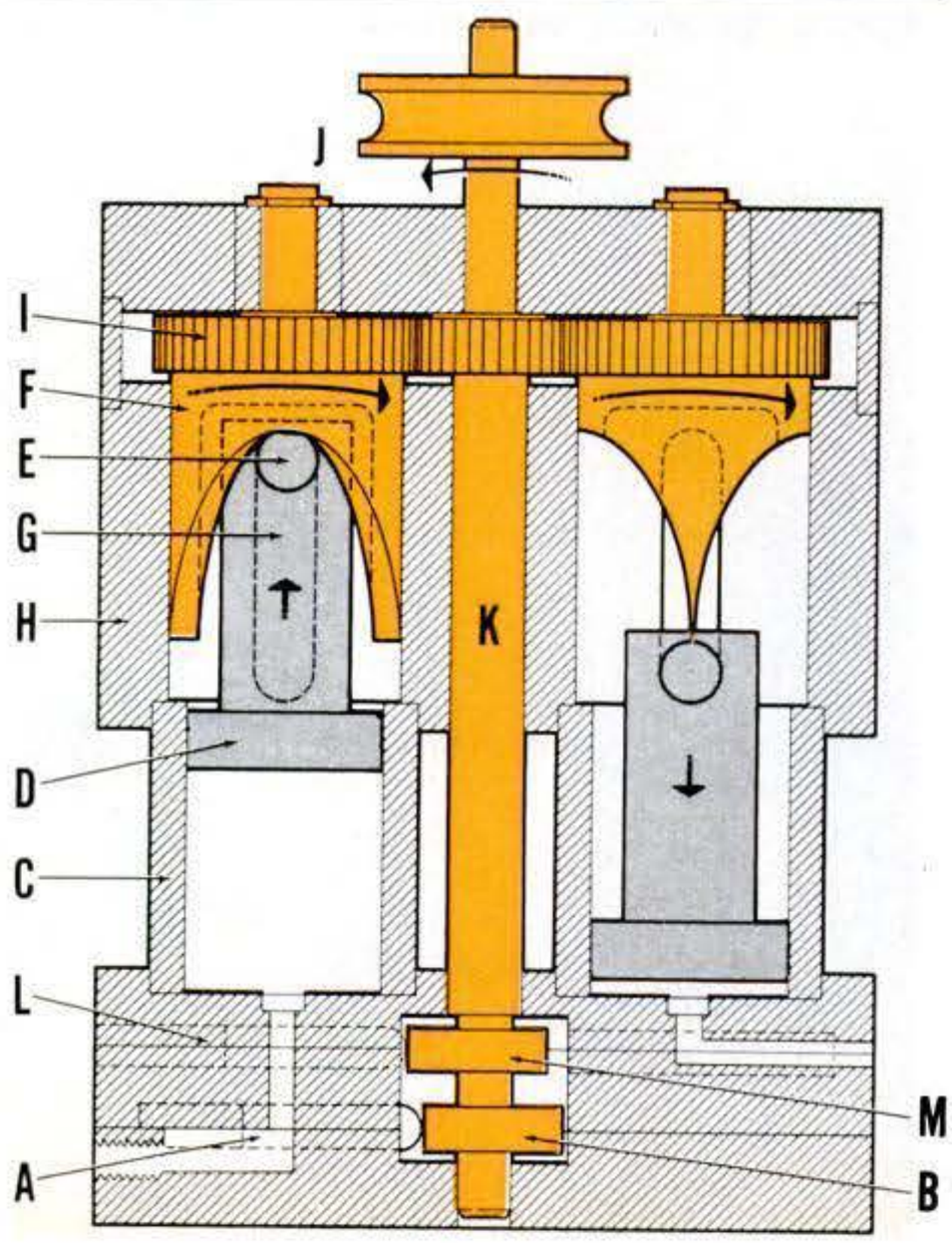
After the air is shut off and the piston reaches the top of its stroke, the inner rollers sweep over the troughs of the rotor's forked cams. With continuing rotation of the gears, the reverse cam profiles force the rollers and hence the piston down, and the exhaust valve opens to release the air. The rollers then ride over the cam peaks, and the cycle repeats.

The motor is a slow runner, with 1000 rpm about its maximum. Efficiency is claimed to be very high, around 80 percent.

The kid's version is made entirely of plastic moldings, and can be run by a bicycle pump. Power is very low, so there's no danger to probing fingers. The first industrial project will be an eight-cylinder opposed-piston unit developing 20 hp with air at 88 p.s.i. PS



Main components of one cylinder include two-pronged rotor with integral gear (front left), piston (center), and cylinder (right). Upper-cylinder block and assembled motor are behind.



Compressed air from inlet valve (A) operated by cam (B) is released into working cylinder (C). Piston (D) with fixed upright rod thrusts up, and inner roller (E) bears against arch-shaped cam of rotor (F), making it rotate. Outer rollers on piston rod run in vertical guide slots (G) in upper cylinder (H), preventing piston from turning as it reciprocates. Gear (I), integral with rotor, drives central pinion (J) on output shaft (K). On downstroke, air exhausts through valve (L) operated by cam (M).

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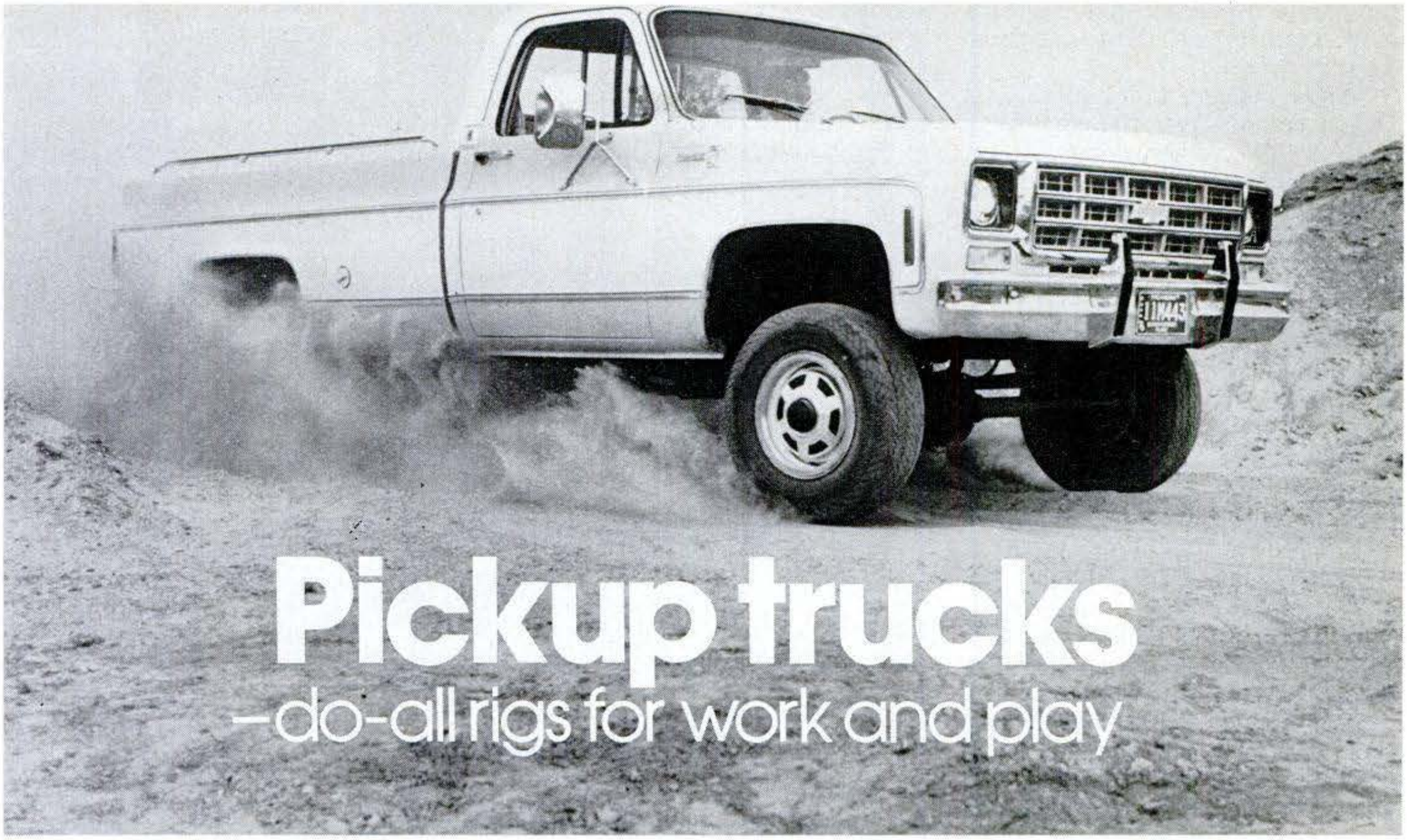

Pickup trucks
—do-all rigs for work and play

Chevrolet's big, tough, go-anywhere one-ton pickup has new four-wheel-drive capability. Yet its cab's many sedan-like features make it pleasing and comfortable. Fancy styling and special wheels, tires, and paint patterns dress it up.

They're tough on the outside, soft in the cab—and almost everyone seems to want one

By JIM DUNNE

The top-selling personal vehicles in the U.S. today aren't cars, but pickup trucks.

At Chevrolet, where some 500,000 Fleetside pickups were made last year, the Chevrolet Impala/Caprice sedan is only the second best seller. Ford's pickup sales last year lagged behind Chevy because of the labor strike, but they still topped sales of Granada, Ford's second best seller, by more than 200,000. Combined, Ford and Chevrolet accounted for more than 1½ million of the two million pickups sold in 1976. Dodge sold about 160,000, while International, Jeep, GMC, and the imports divided the rest of the market.

What's behind the shift? "It's partly a change in life style," says Ford truck-marketing expert Paul H. Manske. Dodge truck sales manager Robert H. Kline agrees: "We now aim our new trucks at surfers, beach people, bikers, and outdoorsmen." It's clear that such buyers—who drive for fun and relaxation—are generating the pickup boom. Right now Dodge is selling more pickups for personal transportation than for work use by a 55- to 45-percent ratio.

"All the growth in pickup sales through 1980," says Kline, "will be in what we call 'trick trucks,'" —the ones with fancy paint jobs, wide wheels, deep-lug tires, and an occasional glass vent roof. "They're designed to meet the new demand."

There's also a growing demand for four-wheel-drive pickups. The reason? Auto-company product planners say that the truck is the single vehicle best equipped for the rugged demands of outdoor sports

Continued

Ford F-250 offers a tremendous range of engine options—from a standard 300-cu.-in. in-line six to a 460-cu.-in. V8. Cab interior shows the influence of sedan styling. Passenger-car features such as power assists add to comfort.

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and recreation. It has a big carrying capacity, four-wheel-drive capability, and a chassis that can take more punishment than most sedans.

"We're making them more carlike in some ways, though," says Manske. "We've developed a soft ride, equipped them with air conditioning, with built-in power assists so they drive like cars, and upgraded the interior trim to make it more attractive."

Here's a look at what the truck makers offer for '77:

Scout Terra, rated at one ton, is pickup version of International's Scout II. Its size and the availability of a fuel-stingy diesel are unique.

Grille and nameplate are virtually the only differences between GMC and Chevrolet pickups. This GMC Crew Cab seats six and has four-door convenience.

Chevrolet

Four new four-wheel-drive models in the one-ton class are available this year. They come in the two-door and four-door Bonus Cab and Crew Cab Fleetside body styles.

Engine choices include 250-cu.-in. and 292 six-cylinder types and V8's of 305-, 350-, 400-, and 454-cu.-in. displacement.

Chevrolet now offers four-wheel drive in its three levels of pickup truck, the ½-ton C-10, the ¾-ton C-20, and the one-ton C-30 series.

Styling changes for 1977 include a new grille and headlight treatment, new seat trim, and a two-tone paint and striping option for Fleetside. The new grille is easily recognizable as a Chevrolet design, but has a bolder, wider pattern.

Chevy's sedan-like pickup, the El Camino, also has a new grille, although, like the truck, the general appearance is unchanged. This model is similar in many ways to the Chevelle sedan, and it benefits from the changes made in that model. Corrosion resistance throughout the body and chassis has been improved, too.

In a model lineup whose variety rivals that of many passenger cars, Chevrolet offers two cabs and two body styles. The basic model has a three-passenger, one-seat cab. Optional cab layouts include a Bonus Cab and a four-door Crew Cab that seats six passengers in front and rear bench seats. Chevrolet calls its styled cargo-box trucks the Styleside, while the traditional pickup design is the Stepside. Optional power door locks and power windows are an industry first for pickups.

GMC

This pickup line is identical to Chevrolet's except for the name and minor styling details.

An interesting new offering from GMC is the Sarge, a special-edition wideside pickup with color and trim similar to that of the GMC General heavy-duty truck. Its paint and trim are inspired by GM's big over-the-highway hauler. The Sarge can be ordered in ¾-ton conventional or four-wheel-drive series. It has special bright forged aluminum wheels with acorn-type lug nuts, raised-white-letter tires, body side rails, a leather-wrapped large grip steering wheel, and an AM/FM stereo radio and eight-track tape player with an integral CB radio.

Jeep

Three basic models are offered for 1977: the J-10 in both 119- and 131-inch wheelbase, and the J-20 in the 131-inch wheelbase. All have four-wheel drive.

This year the base engine in the two J-10 models is the new two-bbl.-carburetor, 258-cu.-in. in-line six. On the J-20 line, the AMC 360-cu.-in. V8 is the standard power plant. The gross-vehicle-weight rating for the J-20 has been hiked from 6500 to 6800 pounds. Optional GVW ratings have been boosted 400 pounds to 7200 and 8000 pounds.

The distinctive Honcho package, which offers special exterior paint and trim items, interior fabrics, carpeting, and steering wheel, has been carried over for 1977 with little change. It is available only in the J-10 119-inch-wheelbase model.

A mixed lineup of engines, transmissions, and four-wheel-drive systems is available. Optional engines on the J-10 include the two 360-cu.-in. V8's and the 401 V8. Options on the J-20 are the four-bbl.-carburetor 360- and 401-cu.-in. V8's.

The full-time Quadra-Track four-wheel-drive system is standard only on models with the 401 engine. It is an option with every other engine. The standard four-wheel drive used with the other engines is the Dana 20 manual type (which should be shifted to the two-wheel mode on dry pavement).

Dodge

Dodge calls its flatside pickup the Sweptline, while the traditional body is called the Utiline. Each is offered in the ½-ton 100 and ¾-ton 200 series in both two- and four-wheel drive. The one-ton Sweptline 300 is available only in two-wheel drive. The units are designated D for two-wheel, and W for four-wheel drive.

Dodge was one of the first to

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Newest pickup from Dodge is this Power Wagon, which offers an eye-catching paint job, four-wheel drive, and other action features. Short wheelbase is a strong

new trend. Club Cab interior is recent innovation with cargo room behind seat.

Four-wheel-drive Honcho from Jeep has a J-10 chassis. Engines range from a 258-cu.-in. six to a 401-cu.-in. V8. Full-time 4WD is standard with the 401.

offer additional space behind the driver in the two-door pickup model. It offers the expanded Club Cab, which continues as a popular model, alongside the conventional three-passenger cab and the six-passenger Crew Cab. The Club Cab's standard wheelbase is 131 inches, but a 115-inch wheelbase is also available in both D100 and W100 models.

The Warlock and Power Wagon are special new models aimed specifically at the personal-transportation buyer. The Warlock features black body paint, lots of gold striping, glass vent roof, and oak wood stake box extenders, producing a mixture of nostalgia and muscle on a vehicle that's rugged enough for the toughest hauling jobs.

The Power Wagon, Dodge's latest pickup, has rugged four-wheel drive, special paint treatment and wide wheels, and heavily lugged wide tires.

International

The Terra adaptation of the Scout II remains as International's lone entry in the pickup market. Based on the utility vehicle body, the Terra offers a unique size to go along with some special options.

Three gasoline engines are available, ranging in size from the 196-cu.-in. four through two V8's of 304- and 345-cu.-in. displacement. A special option is a 198-cu.-in. six-cylinder diesel, made by Nissan, available on all Scout models. The engine is specially designed for work requiring four-wheel drive and 15,000 to 20,000 miles of driving per year. The engine is claimed to give 22 to 28 mpg.

International rates the Terra as a one-ton pickup with a towing capacity of up to 5000 pounds, depending on the engine and power train. It is available in one size with a six-foot box length.

Because of its close relationship to the Scout II, the Terra naturally offers four-wheel drive with all engines. International uses a part-time system that can be switched on or off by a simple push/pull lever on the instrument panel.

Ford

Three body styles are offered in the Ford pickup line again for 1977—the standard cab, the Super Cab, and the Crew Cab. They come in F-100, F-150, F-250, and F-350 sizes with wheelbases ranging from 117 to 166.5 inches. Styling includes both the Styleside smooth-rear-fender look and the traditional separate-fender appearance of the Flareside.

Ford offers one of the most extensive engine lineups in any pickup line. It includes the 300-cu.-in. in-line six, which is standard on the smaller models, and the optional 302-cu.-in., 351-cu.-in., 400-cu.-in., and 460-cu.-in. V8's. Top GVW rating in the F-350 pickup is 9900 pounds, with a maximum load rating of 5355 pounds. Four-wheel drive is available on some models.

In addition to the base car, three levels of trim are available—the Ranger package, the Ranger XLT, and the XLT Luxury Group. Trailer-towing capability of the biggest pickups ranks with the heaviest in the industry. An F-350 will easily pull a 6000-pound trailer.

A number of improvements have been incorporated in the 1977 lineup, including a DuraSpark ignition system that provides higher voltage during startup and low-speed operation. Starting voltages are now 42,000 vs. 32,000 last year, while low-engine-speed voltages are 36,000 vs. 26,000. Corrosion protection has been improved in a number of areas, especially the fenders. Plastic inner shields are used to control road splash and defeat corrosion from inside the fender before it has a chance to start. Precoated steel and galvanized steel are also used in critical areas throughout the chassis.

Ford's slick-looking Ranchero sedan/pickup has a new front-end appearance for 1977, thanks to the changes in the LTD II line on which it is based. Three models are offered—the 500, the Squire, and GT—and their interiors are just like those in the LTD II line. PS

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Good design, good price, good sense– No-frill campers

Here's an alternative to the big gas guzzlers that masquerade as RV's

By HERBERT SHULDINER

With memories of long lines at gas stations fading rapidly, recreational vehicles are off on a growth boom. Most RV's for '77 are bigger, more luxurious, and more fuel-thirsty than ever. What's more, many are no longer suitable for camping.

But if you're turned off by these gas guzzlers that aren't ideal for camping trips, take heart: There's an alternative in new rigs that are smaller, versatile, less expensive, better suited for rough country travel, and often get more mpg.

These rigs include a new class of micro-mini motor homes (some shorter than intermediate station wagons), trailers that can be towed by small cars, campers that mate with fuel-stingy light pickup trucks, and rugged four-wheel-drive campers that are ideal for trips off the highway.

Two of the smallest travel trailers are the Serro Special Edition and the Playmor 135, shown on page 108 These are best for use by two people, but are adequate even for families with one or two small children. A word of caution, however: If you try to shoehorn a crowd in, they can be very uncomfortable.

Need more room? Fold-down camping trailers may be the answer. New '77 models from Apache, Coleman, and Starcraft, among others, have many travel-trailer features. Yet they are easier to tow than standard travel trailers and usually go farther on a tankful of gasoline.

The most popular RV's are still travel trailers that are 20-24 feet long. These provide lots of living space, and are also fairly easy to tow with intermediate cars. One of the more stunning engineering achievements for '77 is the 20-foot Argosy Minuet. This lightweight trailer is built with aluminum skin over an aluminum frame, like an aircraft. The result is a trailer light enough to tow with compact cars.

The class of RV currently enjoying the biggest sales spurt is the mini-motor home. Surprisingly, many of these camping rigs aren't so small anymore. Some "minis" this year have stretched out as much as 27 feet in length and rival many standard motor homes in spaciousness inside.

Continued

A super van conversion? Titan's new 17-foot Bantam mini-motor home has smooth aluminum sidewalls and big side windows for lots of light. It's built on a Dodge cutaway van chassis with a 109-in. wheelbase.

Interior of Titan Bantam has fully-equipped galley and ample work space for meal preparation. Four people can sleep in cabover bunk and dinette that converts to double bed. Price is about $11,000.

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Four-wheel-drive camper from GMC, the Casa Grande, is built on a Jimmy chassis. Body is built by Chinook. The camper has a stove, refrigerator, dinette, and sink. It can sleep five with optional bunks. Top pops to provide over six feet of head room. Price: $10,345-12,425.

Deluxe off-road rig for surf fishing or hunting is the new Santana four-wheel-drive Chuck Wagon. It's built on a Ford Econoline 250 chassis with a front-drive axle installed by Pathfinder. Inside there's a two-burner range and ice box. Price: about $13,000.

Newest micro-mini motor home is the Caravelle from Cobra. It weighs 6500 pounds and has a 210-in. overall length—slightly more than an Oldsmobile Cutlass. It sleeps four and has complete galley and toilet facilities. About $12,535.

First of the compact mini-motor homes was the Tioga II, which has been restyled for '77. It's only 201 inches long, weighs just 5225 pounds (dry and empty). It sleeps three and is fully self-contained. It costs $11,000.

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Hybrid camper from Carefree of Colorado is the Tent Kapper—a cap that fits into a pickup bed and then pops open into a tent camper. It has padded nylon bunks, screened windows, privacy curtains, carpeting. Price: about $750.

Lightweight Playmor 135 is 13'6" long and weighs 1190 pounds. Hitch weight is 125 pounds, so it can be towed by subcompacts. It sleeps four, and has a sink, two-burner range, and ice box. Skin is made of aluminum. Price: $1895.

New Special Edition, a 14-footer from Serro for two people, contains fully equipped kitchen: three-burner range, ice box (refrigerator is optional), sink, and water tank. The trailer is designed for towing by small cars. It's about $1698.

There's a new class of minis that really merit the name. They're built on Dodge's newest 109-in. cutaway van chassis. Champion, Fleetwood Enterprises, Cobra, and Skyline Corp. produce a number of these micro-minis that are about the length of intermediate station wagons, yet are surprisingly roomy campers.

Another choice is the growing number of 4WD van conversions that are really compact fishing or hunting lodges. Even more suited for rough country camping are Chevrolet's Blazer Chalet and the GMC Casa Grande. Both are cutaway 4WD's with compact but spacious campers mounted on them.

Campers for mini pickup trucks also provide an economical alternative to gas-guzzling RV's. The small Japanese-built pickups are really fuel stingy and are excellent

[Continued on page 172]

WHO MAKES 'EM

Apache, Vesely Co., 2101 N. Lapeer Rd., Lapeer MI 48446; **Argosy,** Airstream Bldg., Sidney OH 45365; **Carefree of Colorado,** 2760 Industrial La., Broomfield CO 80020; **Chinook,** 567 San Nicolas Dr., Newport Beach CA 92660; **Coachmen,** Box 30, Middlebury IN 46540; **Cobra,** 57784 CR3 S., Elkhart IN 46514; **Coleman,** Box 111, Somerset PA 15501; **Fleetwood** (Santana and Tioga II), 3125 Myers St., Riverside CA 92503; **GMC,** 660 S. Blvd. E., Pontiac MI 48053; **Holiday Rambler,** 65528 State Rd. 19, Wakarusa IN 46573; **Midas,** 55667 C.R. 15-S, Elkhart IN 46514; **Playmor,** Hwy. 63 S., Westphalia MO 65085; **Serro,** Arona Rd., Irwin PA 15642; **Skyline,** 2520 Bypass Rd., Elkhart IN 46514; **Starcraft,** 2703 College Ave., Goshen IN 46526; **Steury,** 310 Steury Ave., Goshen IN 46526; **Sunrader,** Gardner-Pacific Corp., 5415 Napa-Vallejo Hwy., Vallejo CA 94590; **Time Out,** 1700 Waurika Ave., Elkhart IN 46514; **Titan, Champion Home Builders Co.,** 5573 E. North St., Dryden MI 48428.

A growing number of van conversions are being used to tow trailers, especially big ones. Holiday Rambler designed the Club Car (above) especially as a tow vehicle. Rear doors open conveniently to give access to gear. Price is $13,958.

Sleek Sunrader pickup camper is one of the classiest looking RV's made. It's designed to fit small imported trucks; other models fit domestic pickups. It comes with a full galley and sleeping accommodations for four. Price: $3350.

Big sleeper is Coleman's new Saratoga camping trailer. It accommodates eight in two wing bunks and two dinettes that convert to double beds. Weight is 1400 pounds. It has over 21 feet of living room when open. Price: $2345.

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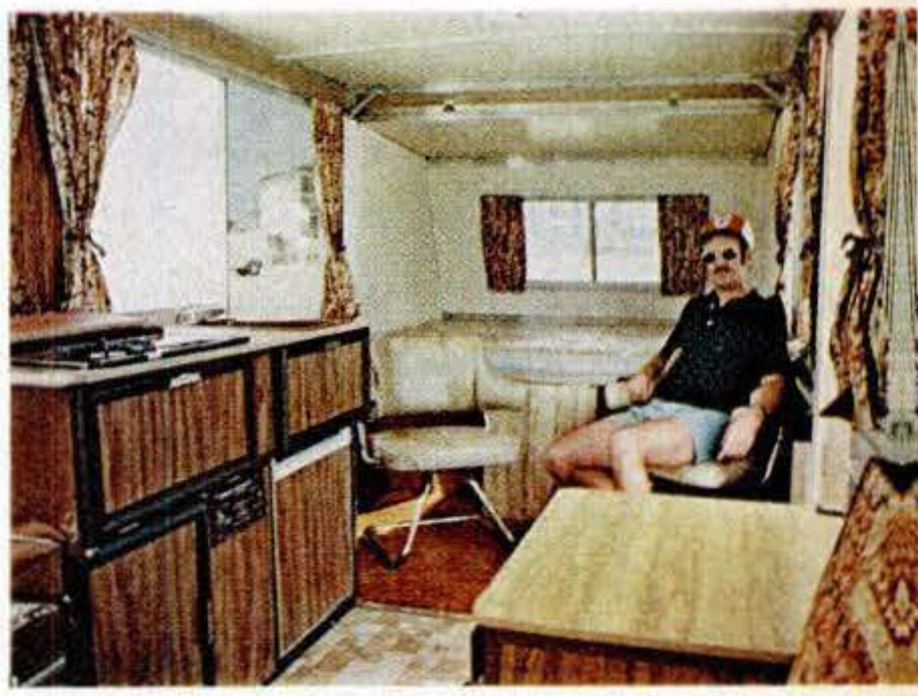

Tent camper without canvas? That's how Apache builds its camping trailers. Newest model, the Cimarron (above), is the first camping trailer with free-standing furniture—chairs and table you can use for outdoors, too. Cost: $3220.

Smoothed walls of Midas' Truck Camper are a laminated sandwich of prefinished aluminum, foam insulation, interior plywood. The 11½-ft. camper sleeps four, has emergency cabover exit, toilet, full kitchen, heater. Costs $3743.

Compact and economical, the 22-foot Coachmen Cadet Travel trailer has most of the amenities of biggest trailers, yet can be pulled by intermediates. It's fully self-contained and sleeps seven with optional bunks. Price is $4535.

Versatile Starlette XL camping trailer from Starcraft makes it easy to be outdoors. It has two slide-out double beds and a dinette that converts to a double bed to sleep six. Range and dining table can be used outside or in. Price: $1846.

A camper with super economy is the Toyota Chinook. The molded fiberglass camper on a lightweight truck gets 28 mpg on the highway. With top popped, camper is spacious enough to accommodate four persons for sleeping. It's about $8300.

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Better quality for less cost: Do your own van conversion

By RAY HILL

It's not hard to see why van conversions are growing in popularity. Many converted vans on the market can give you a home on wheels for much less than you'd pay for a fully equipped motorhome. The van's overall length, actually shorter than many full-size cars, makes it easy to maneuver. Yet it can have an amazing amount of room and comfort inside.

There are disadvantages, too. Van conversions are expensive. You may not get the floor plan you want. And the construction quality may not meet your standards.

There's away to avoid these problems: Do your own conversion. A friend and I did the job in about six months, working evenings and weekends. I saved several thousand dollars, and ended up with a motor home in a van. It has a queen-sized bed, cook stove, furnace, and most of the other conveniences of a full-size motor home. Here's how we did the conversion.

Continued

Some of the components we used for our van conversion

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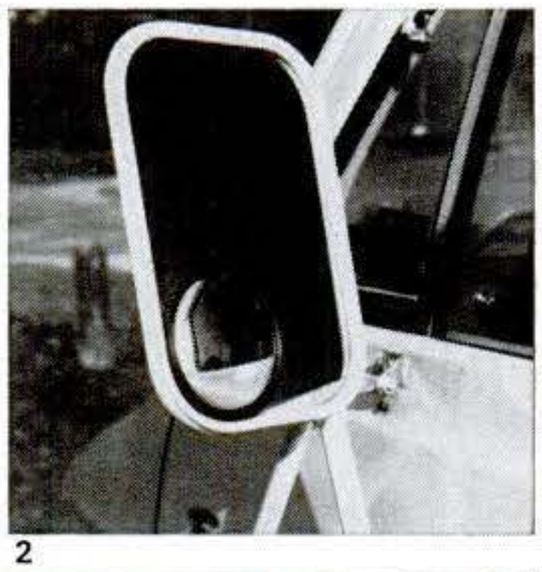

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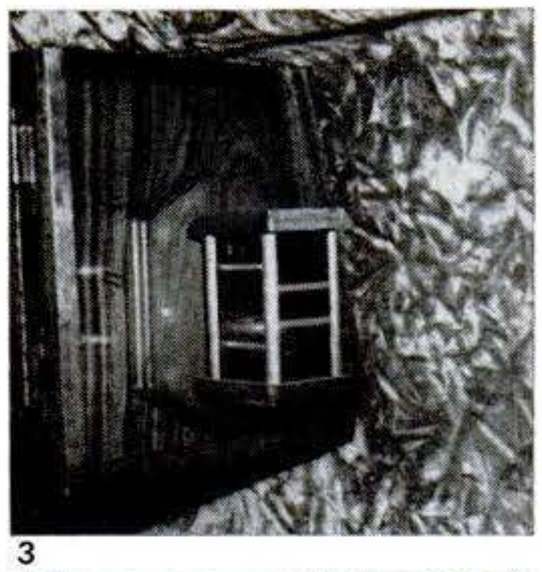

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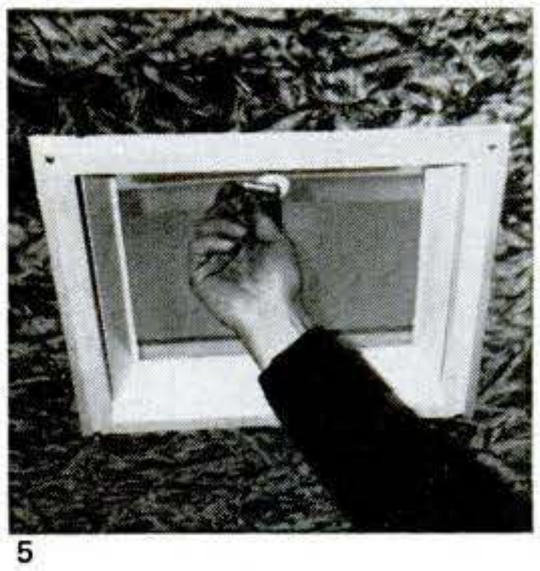

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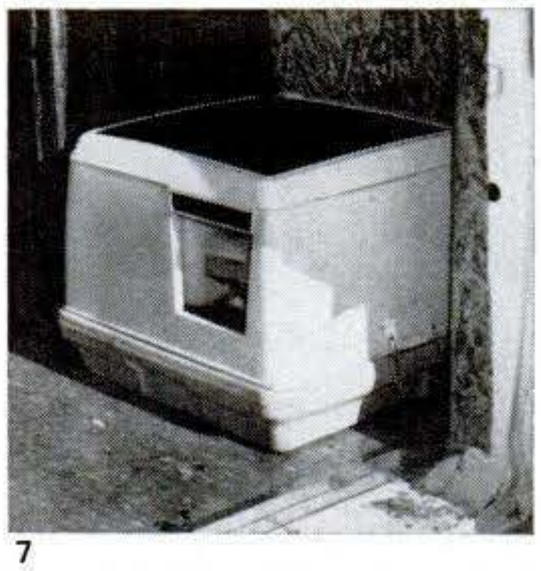

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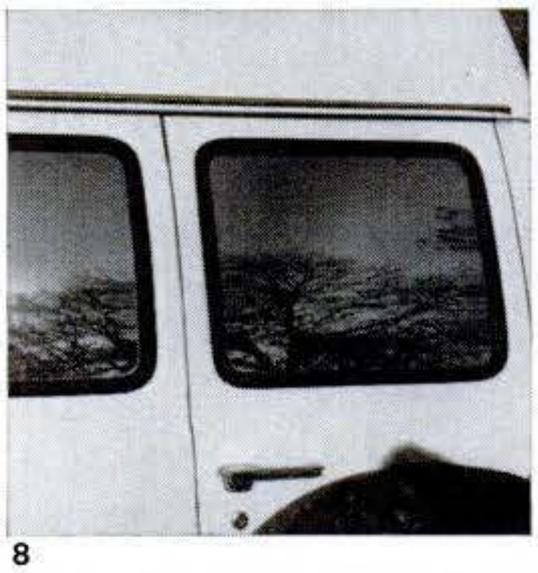

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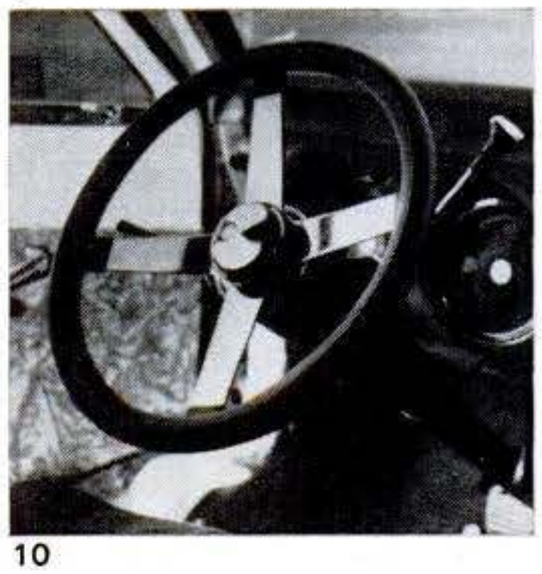

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1. Refrigerator is Norcold Venturer. It has an adjustable temperature control and easily holds enough food for two or three people for a long weekend. It can run off either 12-volt auxiliary batteries or 110 volts. Price is $320, from Sears, Penney's, Wards, or Norcold (Box 180, Sidney, Ohio 45365). **2. Low-mounted mirrors** from J.C. Penney give more viewing area than stock mirrors. Catalog price, $9.99. Small convex mirror was $1.99 at local auto-parts store. **3. Light** is 12-volt Xantech from Penney's. It's easy to hook up—one wire hooks to hot wire, other wire is grounded. Catalog price, $15.99. **4. Furnace** is 17,000-Btu Duo Therm, model no. 65917; about $205. Thermostat lets you control temperature. **5. Vent** is from Penney's. Catalog price, $11.99. **6. Cal Chrome wheels** are from J.C. Penney—catalog price, $40.99. **7. Toilet** is Porti Potti Continental from Thetford. $109. **8. Reflective 3M Scotchtint** keeps sun out of rear windows. Check with local highway patrol before using, for it may be illegal in some states. **9. Vinyl spare-tire cover** is $16.99 from Penney's. **10. Padded steering wheel** is available from Penney stores for $38.99.

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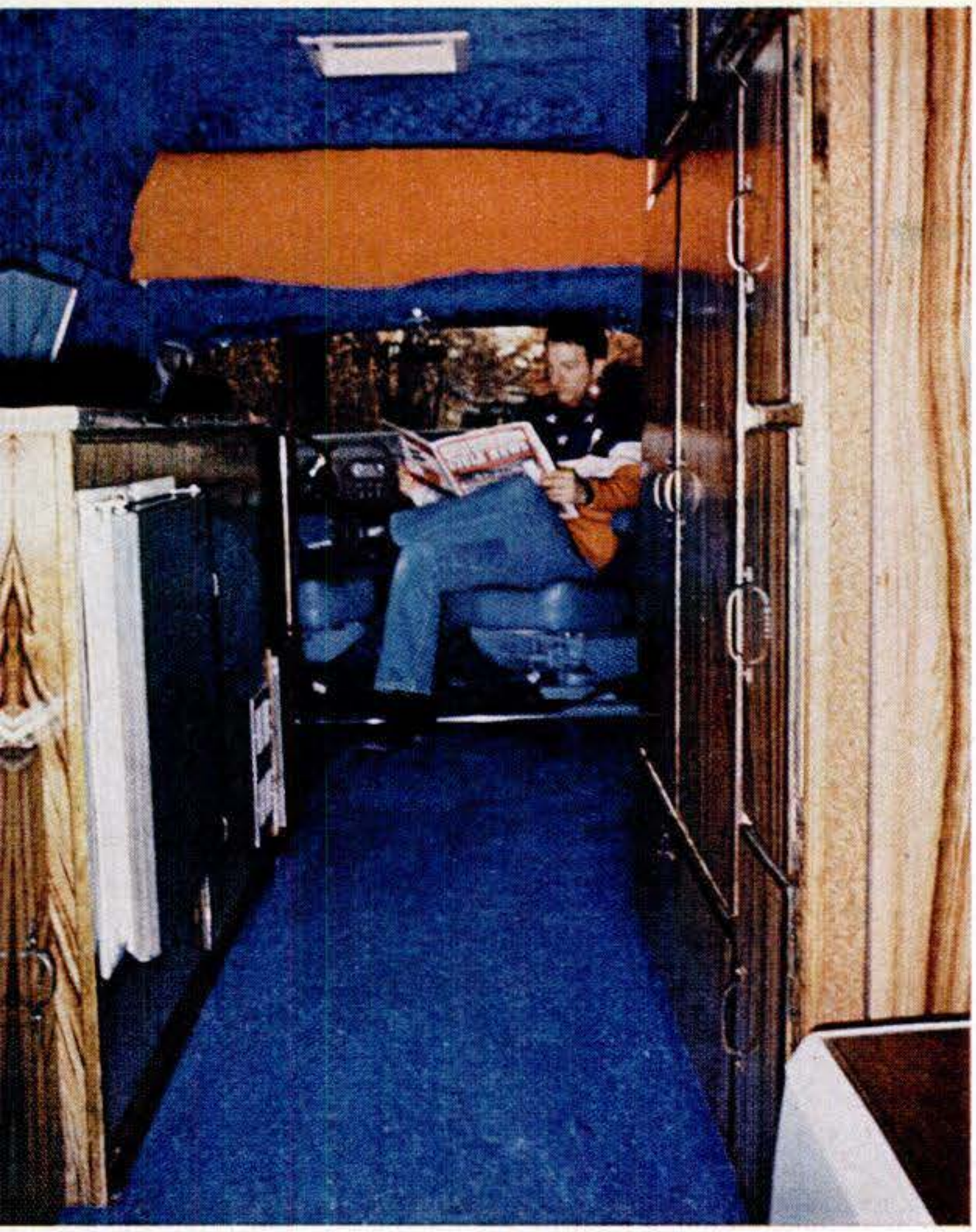
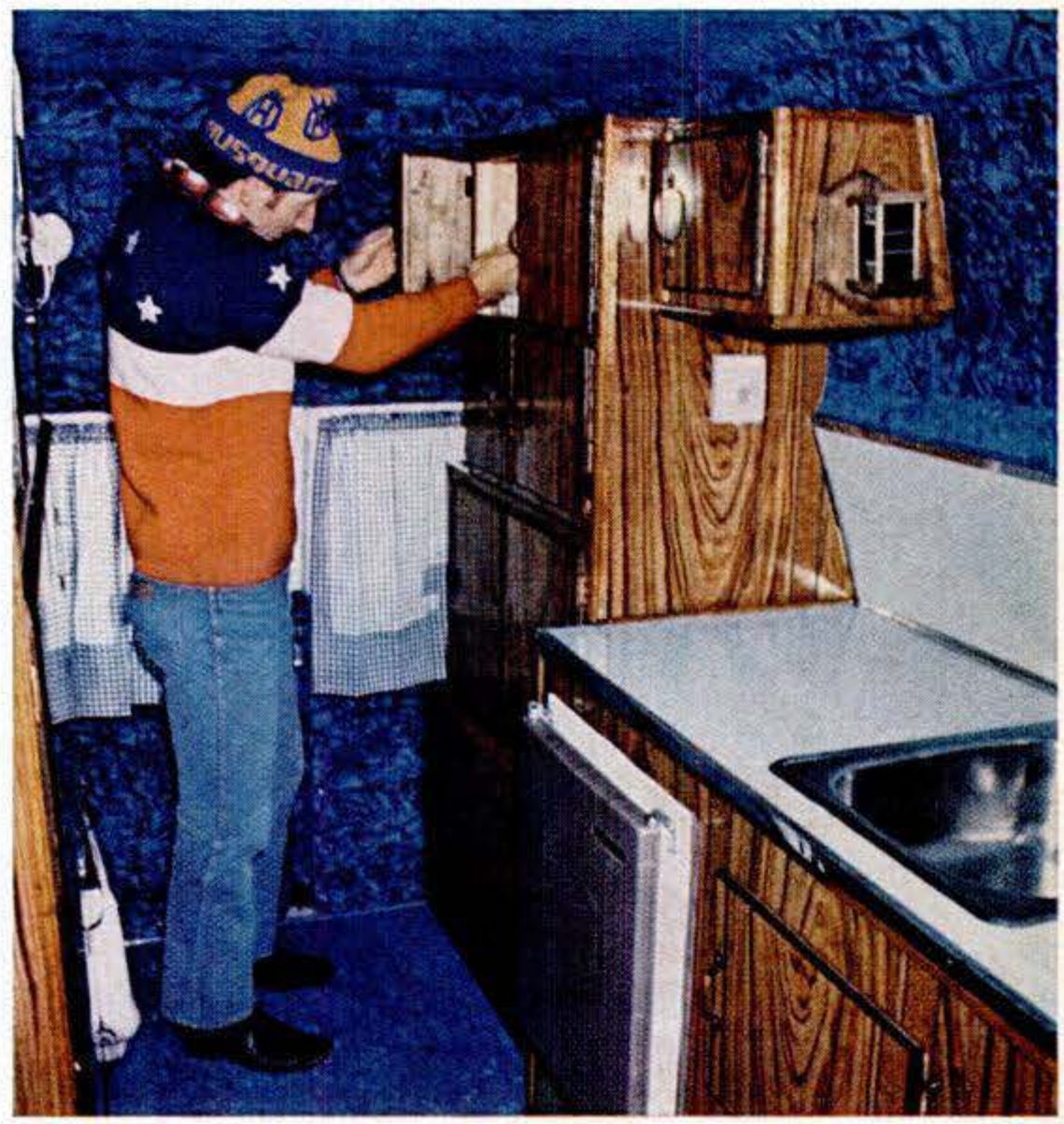
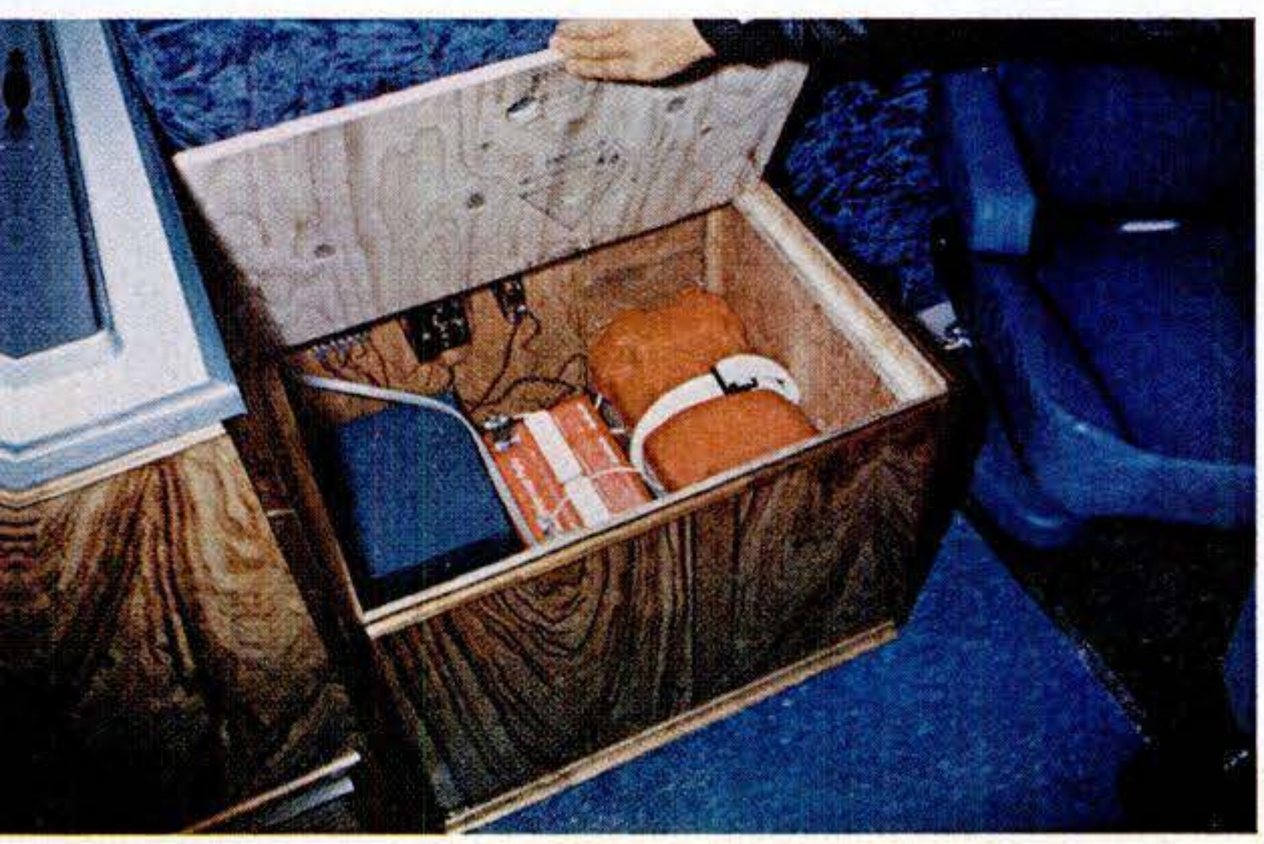


Front seats, with arm rests and high backs, rotate and recline. They're easily installed. Maker is Bostrum Div., UOP, 133 Oregon St., Milwaukee, Wis. 53201. Prices run from $148-$295 per seat (including seat base and everything needed to mount seat). Slide-out bed is above seats. Mattress is giant pad of three-inch high-density foam and is very comfortable. Top half of cabinets, below, is used for dishes, etc.; bottom half holds tools.





Three-burner cook stove (center, left) is from Coleman ($50). Blue velour fabric covering interior is from J.C. Penney. It's available in many colors at $2.99 a foot from the catalog (store price is higher). Scissors, patience, and 3M multipurpose adhesive are all you need to use it. Left, auxiliary batteries rest beneath seat. Above, hallway was built wide enough to carry a motorcycle inside. It also lets van double as light-duty utility truck.

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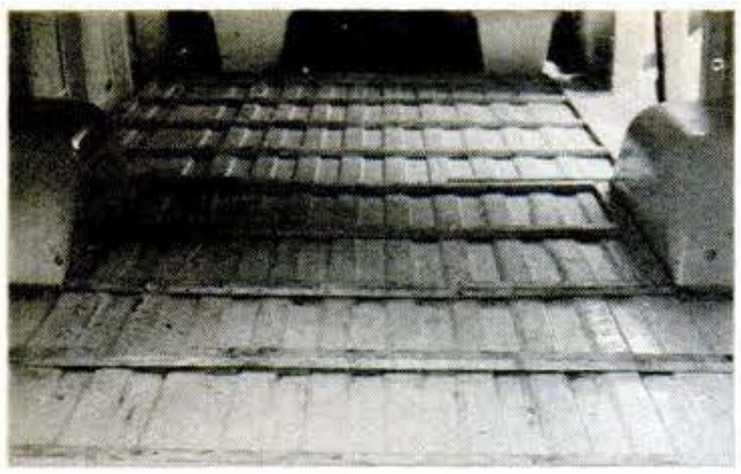
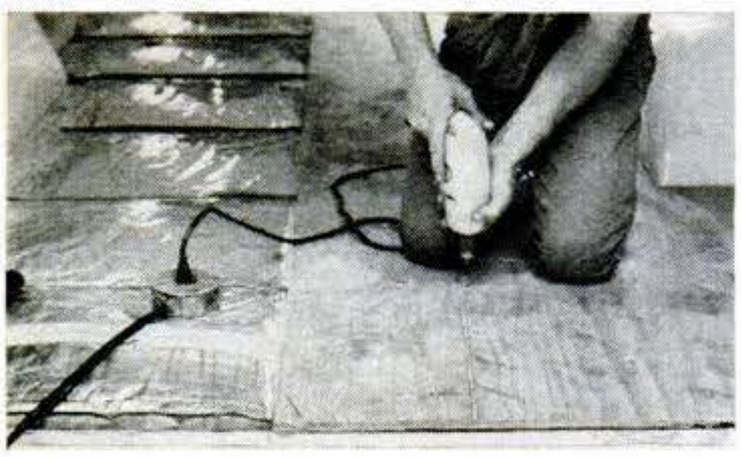
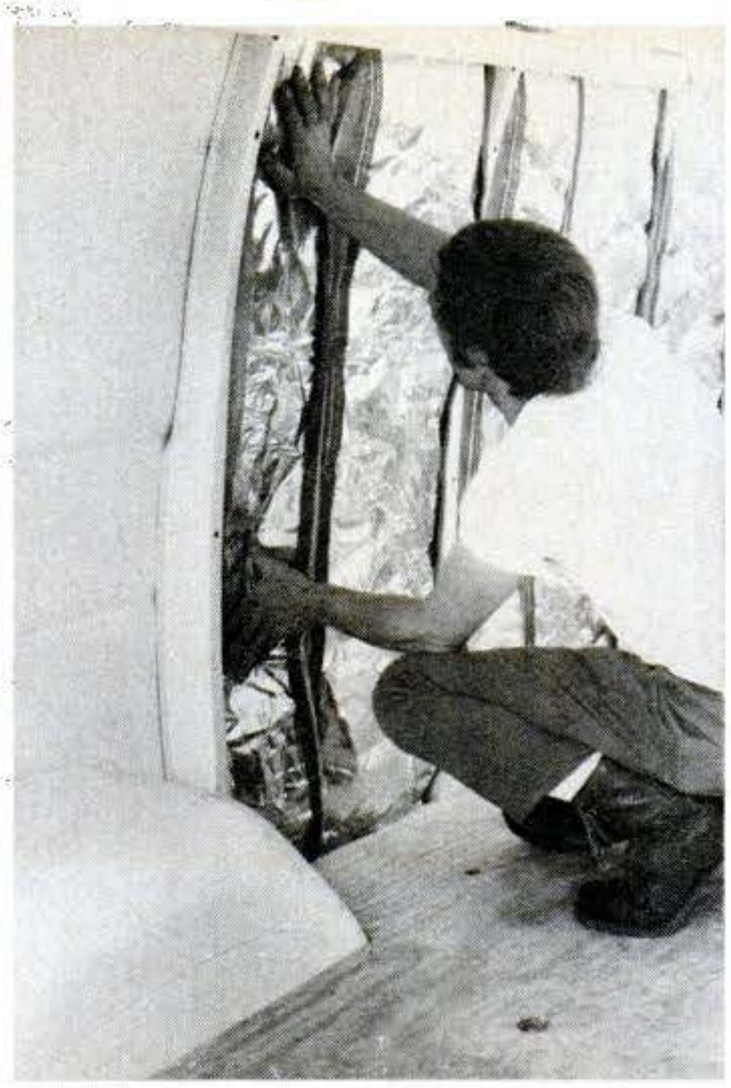


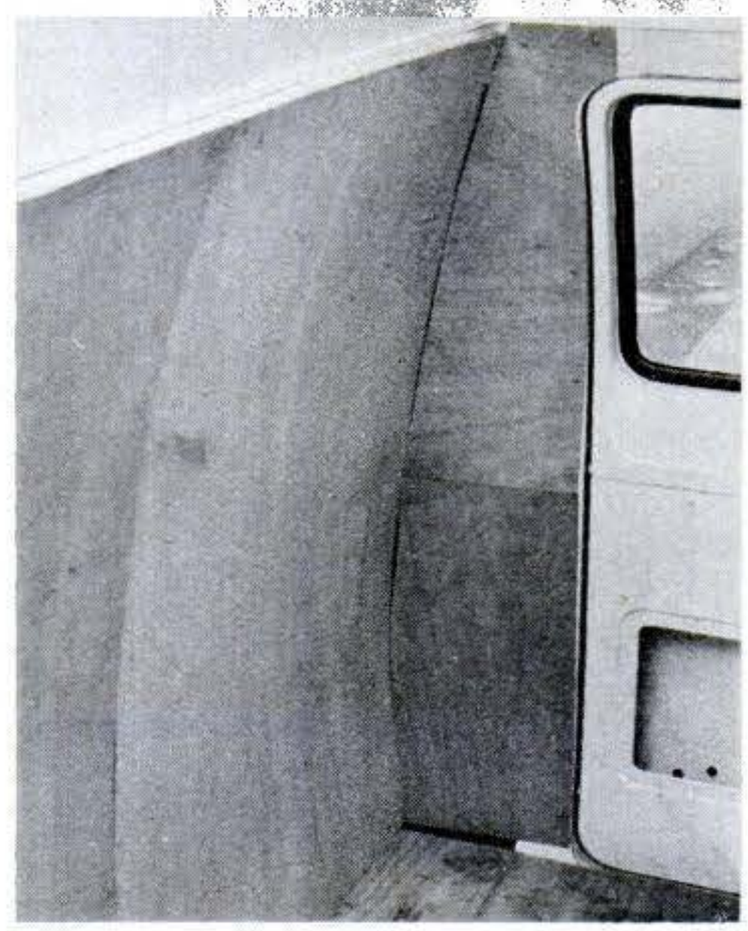
Furring strips are placed 16" apart and bolted to floor. Use bolts with a flat head, slotted for a screwdriver.



When drilling screw holes to attach ½" plywood floor, drill only through the plywood, not into the furring strips.



Installing insulation on walls is easy. Just spray the sheet metal with adhesive, then press the insulation in place.



Thin doorskins bend easily to fit curvature of van's sides. Velour fabric is then glued directly to the doorskins.

My first step was to find a van to fit my needs. All three makers—Ford, Chevy, Chrysler—offer vans with short or long wheelbases and carrying capacities of about ½, ¾, and one ton.

If you expect to carry a lot of weight and want maximum room, you'll want a long wheelbase that can carry ¾ ton or more. On the other hand, if you won't be hauling much weight and don't need a lot of room, consider a short wheelbase with a half-ton carrying capacity. Your pocketbook plays a role here, too. Vans with longer wheelbases and greater carrying capacities cost more money and have poorer gas economy than the smaller vans.

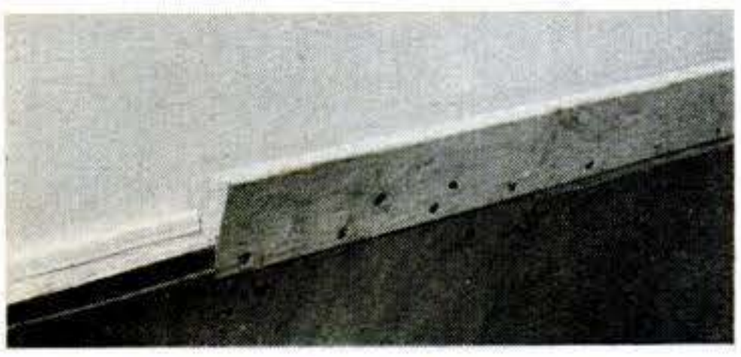
I wanted as much room as I could get, and enough carrying capacity for a passenger, a motorcycle or two (since I'd be taking my van to enduros and race tracks), and the components of the van conversion. So I bought a Dodge Maxivan with about a ¾-ton carrying capacity. I also wanted to be able to stand up in the vehicle when we were camped. So I had Travco install one of its insulated raised roofs.

(A note on roofs: Travco no longer sells or installs roofs, except on their own commercial van conversions. There are, however, several elevated roofs available through RV stores. After choosing the roof you like, it's best to have the roof installed—either by the maker or by a body shop. Most people don't have the experience or equipment necessary for the job.)

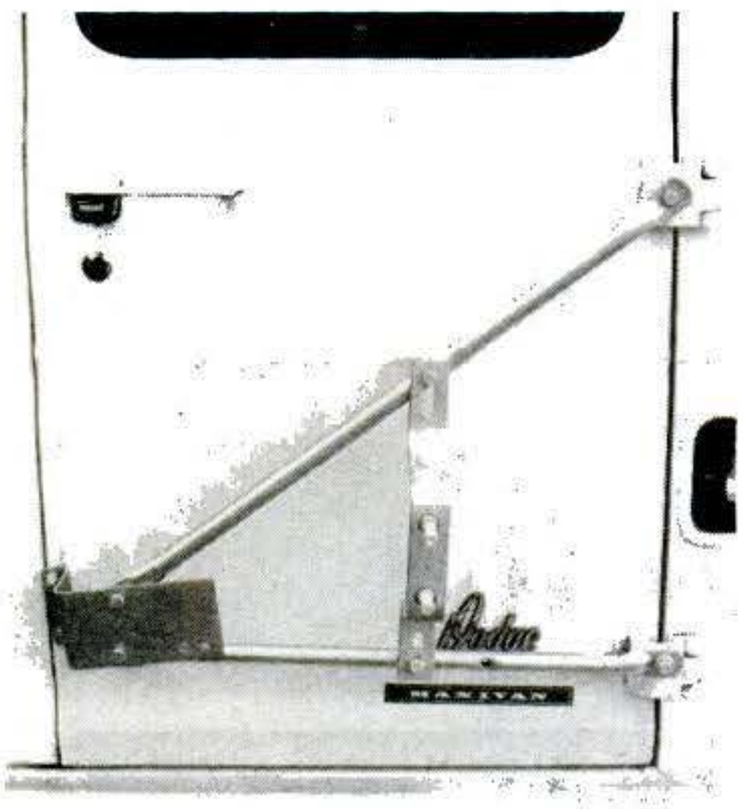
Before we sawed our first board, we went out to the van with a pad, pencil, and tape measure. We knew what components we wanted to put in (see floor plan) and what their dimensions were. But it's important to arrange them on paper for maximum efficiency and space. If you don't make this preliminary floor plan, you may find that you're trying to arrange things in a way that won't fit.

Next step was to install an insulated floor. First we attached 1"-by-2" furring strips to the sheet-metal floor with small bolts. When drilling the bolt holes, we would place a furring strip in position,

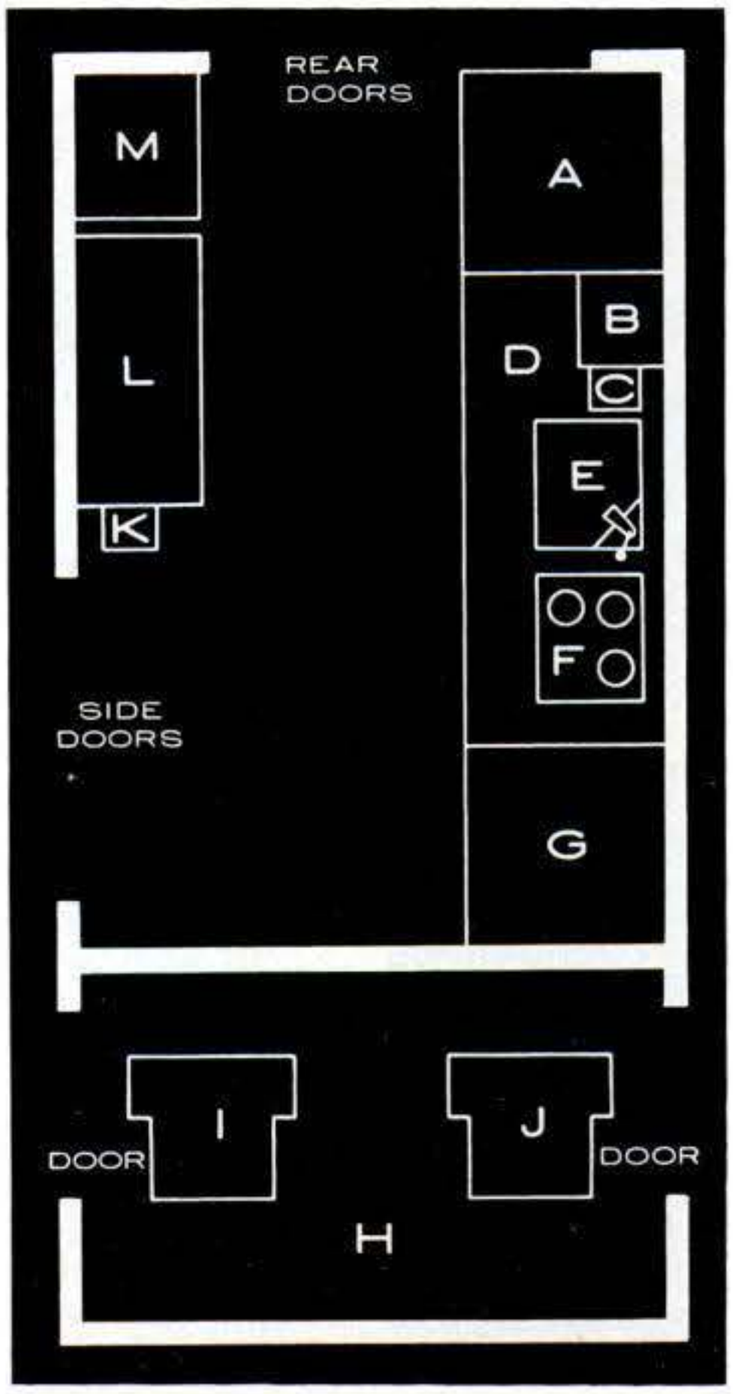
[Continued on page 171]



Two of these 6' rails support the bed. Upholstering the rail is simple—just cut the velour and glue it in place.



Tire carrier is from J.C. Penney and attaches to rear door. It's $18.99 from the catalog, higher in store outlets.



Floor plan: A,B-cabinets, C-light, D-counter, E-sink, F-stove, G-seat, H-bed, I,J-seats, K-light, L-closet, M-toilet.

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PS LEISURE HOME of the month

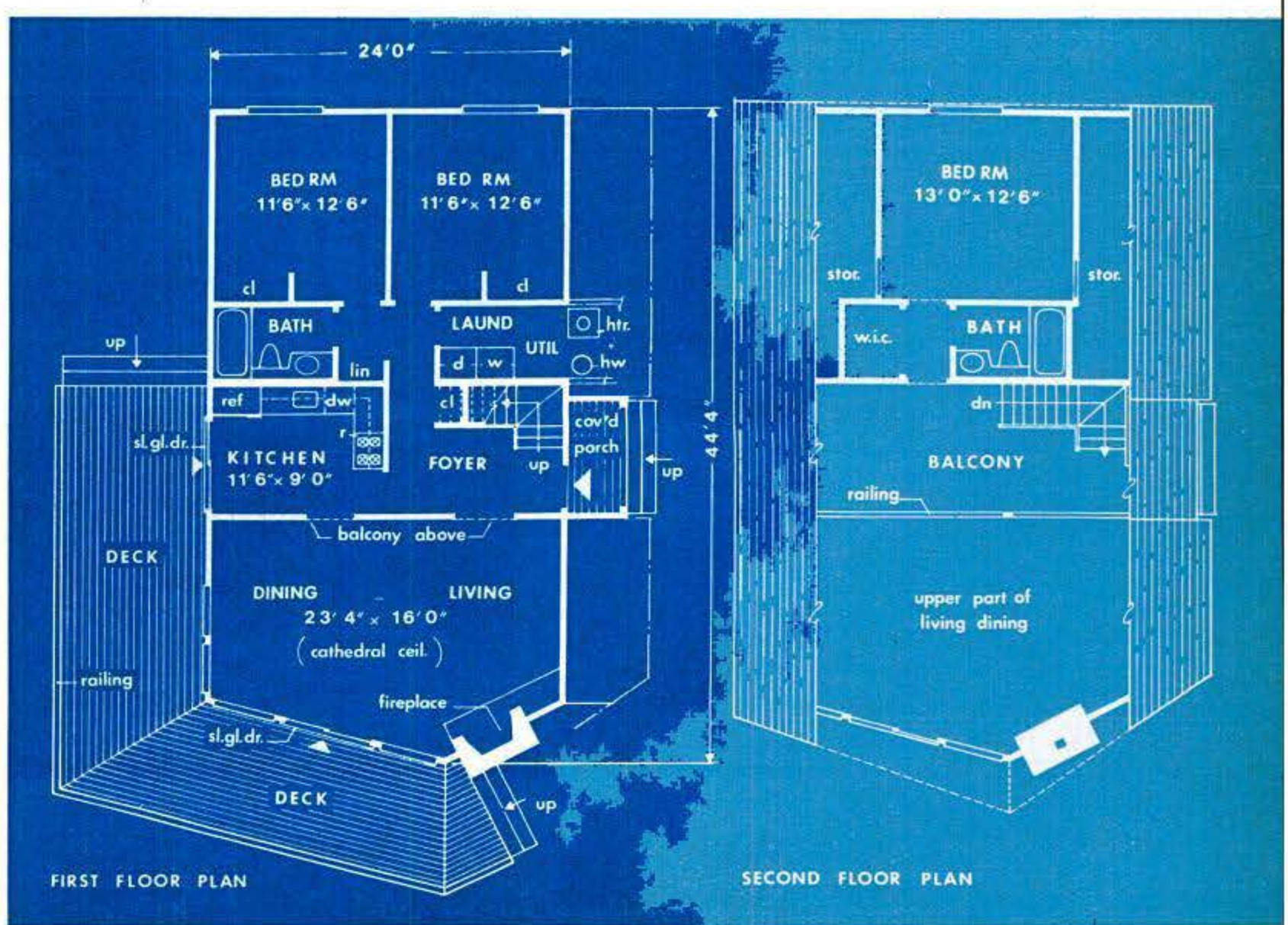
Skewed-prow two-story

If you've got a great view—frame it. That's the philosophy behind this cleverly skewed modification of the popular A-frame. And it applies equally to a mountain vista or a seascape.

The center of the prow is shifted toward the chimney, and the left half of the roof is raised on a wall of nearly conventional height to avoid that cramped under-eaves feeling of a full A-frame. As a result of these variations, the glazed side of the prow expands dramatically. The window even turns the corner to provide a dining area with a view no standard A-frame could offer.

Two widely separated sliding glass doors give onto the ample deck, which adds nearly 500 sq. ft. of living area to the 1015-sq.-ft. first floor. Nearly half of that floor space enjoys the impact of the soaring cathedral ceiling shown in our interior view. The rear portion, how-

[Continued on page 162]



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Parquet floors

you can install yourself

All the luster of real wood protected by baked-in finish and at moderate prices

By SUSAN RENNER-SMITH

What did Louis XIV, Thomas Jefferson, and Cornelius Vanderbilt have in common? They all chose parquet flooring for their homes. From Versailles to Monticello to the "Breakers" in Newport, R.I., gleaming parquet floors were the sign of luxurious living.

Today, you too can enjoy the elegance of parquet floors in your home—without having to spend a fortune. At prices as low as 70 cents per square foot, it's competitive with inexpensive carpeting. You can lay it as easily as tile and many products come prefinished.

The price breakthrough is made possible by shaving the wood a fraction of an inch. Most of today's parquet is 5/16-inch thick instead of the ¾-inch or more that was often used in the past. And factory preassembly cuts installation costs. Most parquet comes in blocks instead of individual pieces. The separate slats are held together by a backing of cloth mesh or thin metal splines. Parquet blocks can range from a 36-inch square (Wood Mosaic's Bordeaux) to six inches (Bruce's Cumberland Oak), but the average size is a 12-inch square.

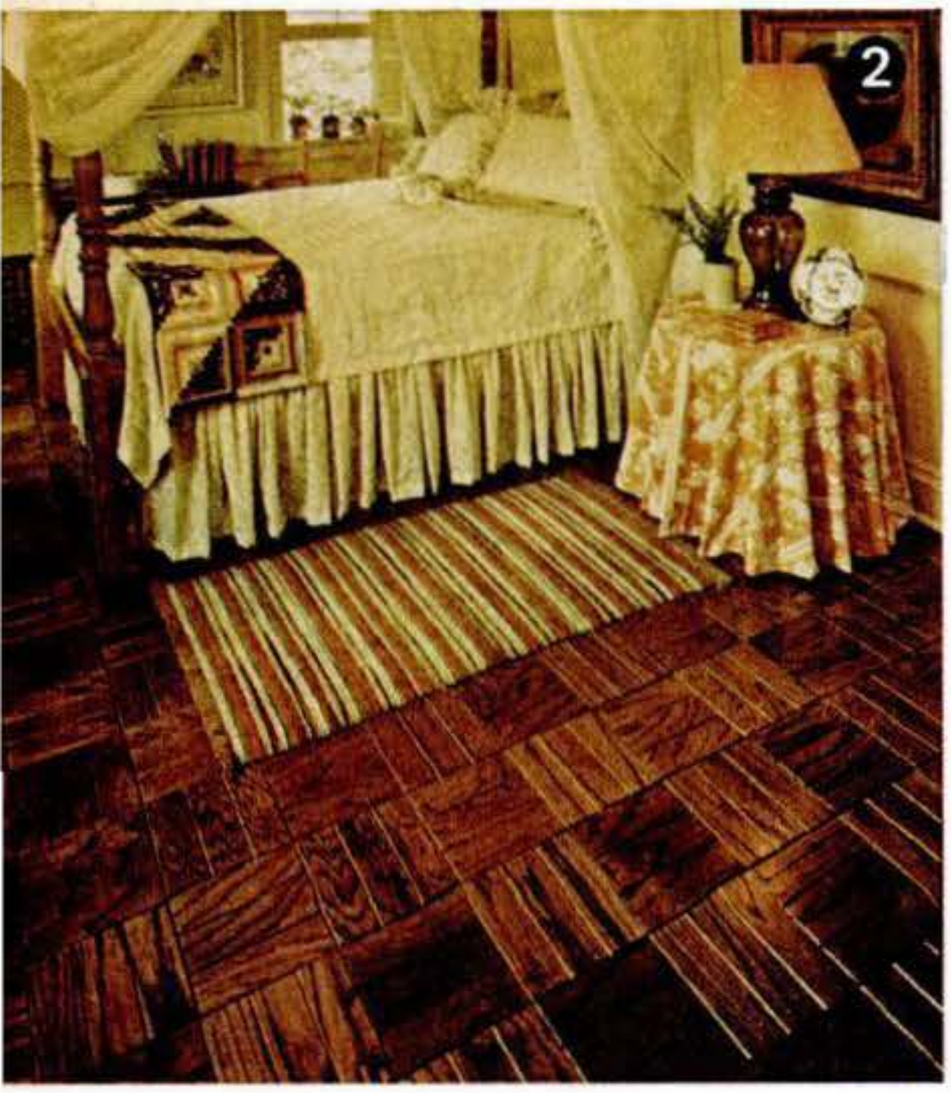
You can install this new parquet over almost any clean, dry, level subfloor—concrete, tile, plywood, or even old strip flooring. Some brands can go on radiant-heated floors (see chart, overleaf) and many can be laid on floors that are at, or below, ground level—such as a basement or a sunken room.

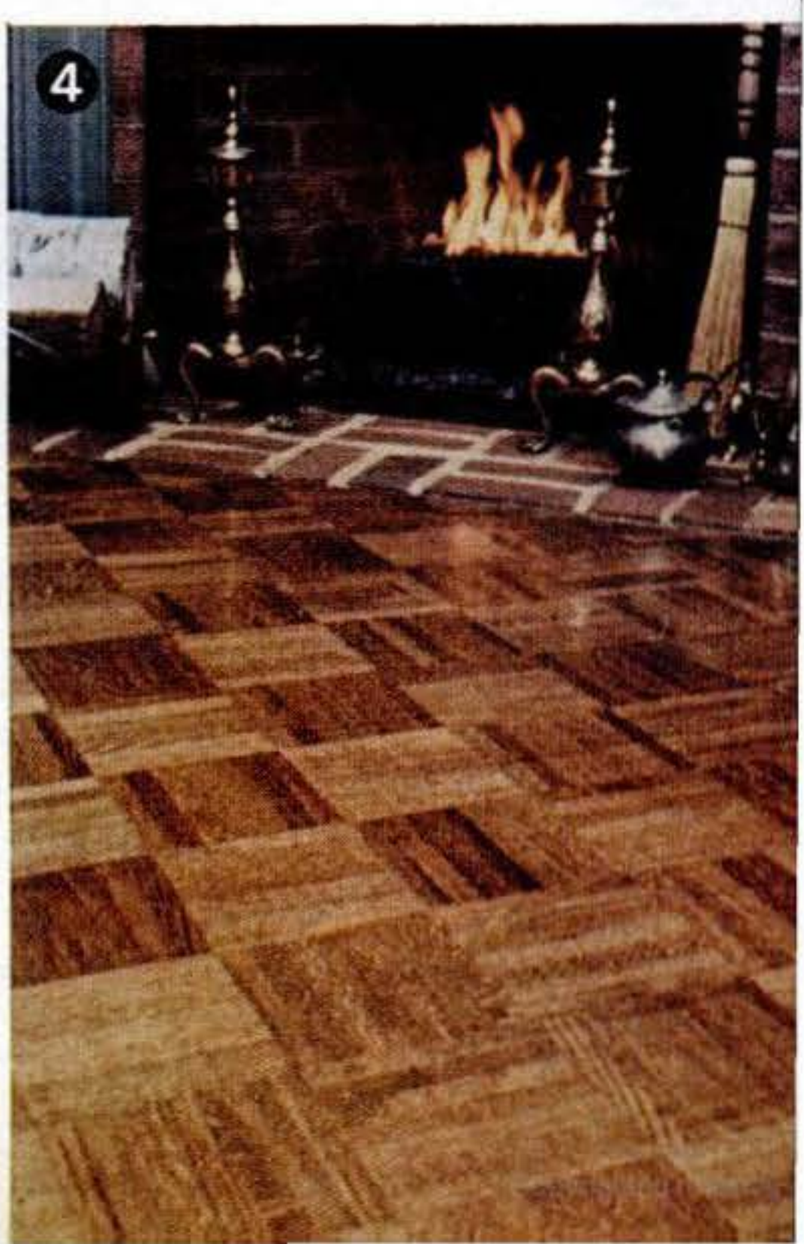
Obviously, today's parquet is less expensive and easier to install —but how long will it last? Don't expect these floors to last as long as those in the French chateaux or even as long as the floors in Monticello. But Dwight Drinkard, of E. L. Bruce, Co., says, "A 5/16" hardwood oak floor will outlast the

[*Continued on page 176*]

Turn page for further information

Stunning parquet floors come in a variety of shades and patterns. Shown here are: Wood Mosaic's Singapore Teak (1), Checkerboard Teak (6), and Bordeaux (7); E.L. Bruce's Mt. Vernon (2), and Teak Mosaic (8); Memphis Hardwood's Patternblok (3) and Herringblock (9); Penn Wood's Flooring Squares (4); and Syke's Monticello (5). For prices, see chart overleaf.





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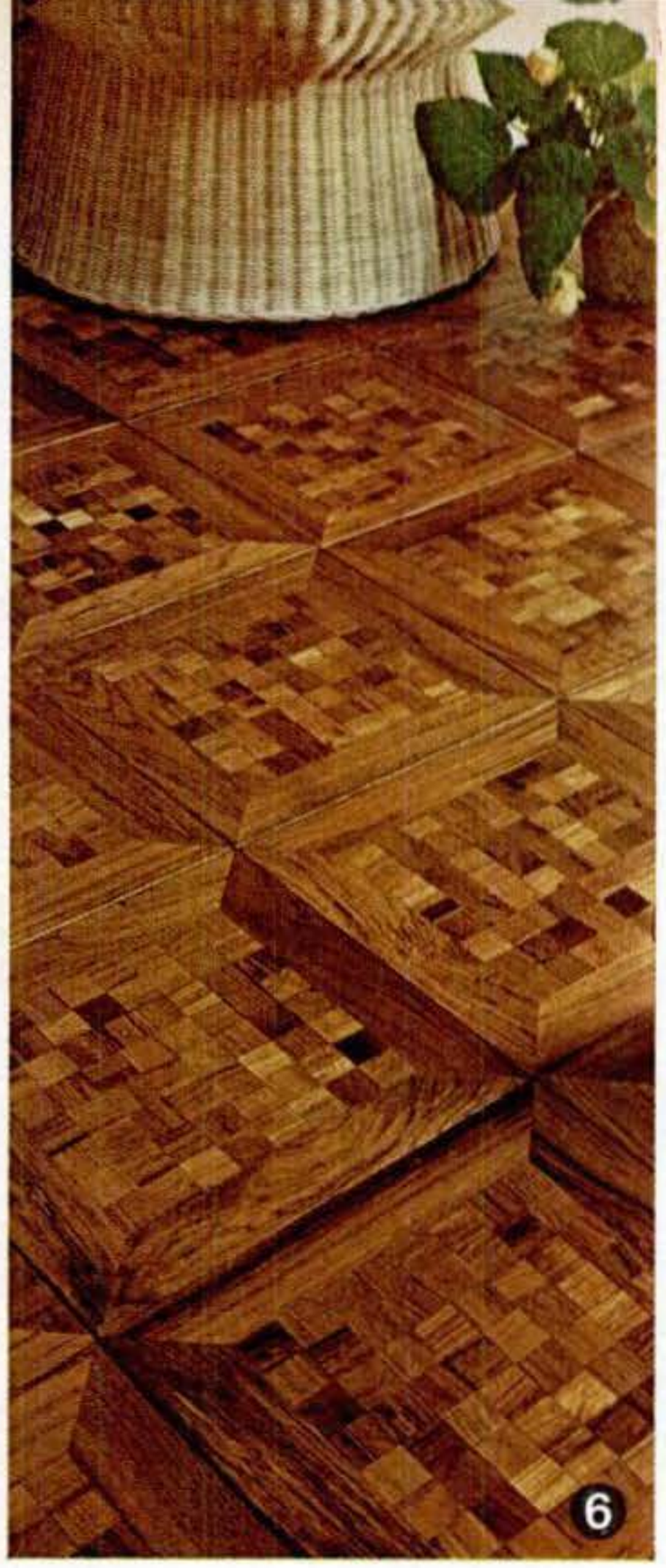

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PS Buyer's Guide to Parquet Floors

Pattern Name	Wood/[1] grade	Dimensions/description[2]	Finish	Sq. ft./ carton	Suggested retail price per sq. ft.[3]	Features and comments[4]
WOOD PARQUET FLOORS (selected patterns)—Bangkok Industries, Inc., 1900 South 20 St., Philadelphia, Pa. 19145						
Straight Line	Teak	5/16" x 12" x 12". B. All Bangkok patterns are solid wood with cotton-mesh backing and slightly beveled edges	Factory prefinished with two coats of penetrating sealer	50	$3.10	SS. One page of instructions without diagrams
Swirl	Same	5/16" x 12" x 12". HH	Same	50	3.10	
Four Square	Same	5/16" x 12" x 12". SB	Same	50	3.10	
Finger	Teak, Karpawood (Asian ironwood)	5/16" x 21" x 12". SB	Same	60	2.30	
DESIGNER OAK (selected patterns)—E. L. Bruce Co., Inc., 855 Ridge Lake Blvd., Box 16902, Memphis, Tenn. 38116						
Haddon Hall	Old English Oak	1/2" x 12" x 12". HH. (Unless otherwise noted, all Designer Oak patterns are made of cross-grained oak veneers, bonded under pressure with waterproof glue for dimensional stability, T&G, with cotton-mesh backing)	Factory-applied penetrating sealer baked into wood; carnuba wax baked in. Buffed. Mellow Brown; distressed surface	15	2.80	SS, but not rubber tiles. Clear, two-page instructions with diagrams
Herringblok	Same	1/2" x 3" x 9" strips. Variety of possible patterns	Factory-finished as above. Mellow Brown (distressed) or Hearth Brown (smooth finish)	15	2.42	
TEAK MOSAIC—Bruce						
	Teak	5/16" x 12" x 12". SW-HH. Cotton-mesh backing; T&G	Factory-finished as above. Autumn Brown or Coffee Brown	25	2.46–2.66	SS, but not rubber tiles; below-grade or radiant-heated. Instructions as above
CUMBERLAND OAK—Bruce						
	Natural, Better, or Old English Oak	5/16" x 6" x 6". SW-B. Spline back; T&G	Factory-finished as above. Desert Brown (smooth) or Chestnut Brown (smooth or distressed)	25	1.00	Same as Teak Mosaic above
WOODLANDS PARQUET—Bruce						
Mt. Vernon	Commercial and Better Oak	1/2" x 9" x 9". Three plies of cross-grain hardwood bonded under pressure with waterproof glue. Two surface grooves; T&G	Factory-finished as above. Mellow Brown (smooth)	18	1.50	SS, but not rubber tiles. Comprehensive, four-page **Do-It-Yourself Installation Sheet,** with illustrations and diagrams
STANDARD AND ANTIQUE TEXTURED—Crown Mosaic Parquet Flooring, Inc., Box 272, Sevierville, Tenn. 37862						
	Natural, Better, or Cabin Oak (rough sawn for antique texture)	5/16" x 6 11/32" x 6 11/32". SW-B. Spline back; T&G	Unfinished or factory finished with two coats of penetrating sealer, waxed and buffed for dark finish; or three coats of moisture-cured urethane, waxed and buffed for light finish	50	34¢–55¢ (price to dealer)	SS, but not below grade. Two-page instructions with one diagram
BONDWOOD—Harris Manufacturing Co., Box 300, Johnson City, Tenn. 37601						
Dura Blok	Natural, Better, and Cabin Mixed Red or White Oak	5/16" x 6 11/32" x 6 11/32". SW-SB. Spline backing; T&G	Factory-finished with two coats of penetrating, pigmented sealer; waxed and buffed. Antique Brown	50.3	80¢	SS, but not resilient tile or below grade. Clear, two-page instruction sheet with photos. 45-page **Technical Notes,** applicable to most brands of parquet flooring, available for $1
Antique Textured	Par and Better Red or White Oak	5/16" x 11" x 11". SW-SB. Web backing; square edge	Factory-finished in five brown shades or five decorator colors	50.4	80¢	
CHICKASAW HARDWOOD FLOORS—Memphis Hardwood Flooring Co., 1551 Thomas St., Memphis, Tenn. 38107						
Monticello	Standard and Better Red Oak	3/4" x 6" x 6" centers; 3/4" x 2 1/4" x 8 1/4". MP. All Chickasaw patterns are solid wood, T&G, with a spline backing	Factory-applied coat of penetrating sealer, waxed and buffed. Antique Brown, Natural, or Weathered (distressed finish)	8.5	3.75	SS. Clear, two-page instruction sheet with detailed diagrams. Comprehensive, how-to sound/slide program for Herringblock installation (much of it applicable to other patterns) available through dealers
Herringblock	Same	3/4" x 4 1/2" x 9". H	Factory-finished as above. Antique Brown or Natural	9	2.50	
Patternblok	Same	3/4" x 6" x 6" and 3/4" x 6" x 12". Units combine to create HH, BW, and others	Same	4, 8	2.75	

Laying parquet in mastic (left) demands careful preparation. Clean the subfloor thoroughly, removing any paint, plaster, or old wax. Prime dusty concrete floors. If they're damp, glue down a moisture barrier of polyethylene film. With a hammer and chisel, remove all moldings; then use a piece of parquet as a guide to undercut doors and jambs. Next, snap two intersecting chalk lines perpendicular to end and side walls to use as guides. Spread mastic with a notched trowel, taking care not to cover chalk lines. Start by laying the first piece at the intersection of these lines, then work toward the wall. To prevent uneven mastic buildup, drop—don't slide—each block lightly in place, and press down firmly. A power saw is handy if trimming is needed at the walls. Be sure to leave from 1/8 to 3/4 inches expansion space (depending on maker's instructions). Base moldings will cover this.

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Pattern Name	Wood/[1] grade	Dimensions/description[2]	Finish	Sq. ft./carton	Suggested retail price per sq. ft.[3]	Features and comments[4]
MICROSAIC HARDWOOD PARQUET—Peace Flooring Co., Box 87, Magnolia, Ark. 71753						
	Deluxe or Cabin Mixed Red and White Oak	5/16" x 6⅜" x 6⅜". SW-B. Plastic spline back; T&G	Factory-applied sealer, filler, two coats alkyd finish, waxed and buffed. Natural, Brown, Walnut, Antique	50	70¢	SS, but not tile, below grade, or radiant-heated. One-page instructions with diagrams
HARDWOOD PARQUET FLOORING—Pennwood Products Co., Locust St., East Berlin, Pa. 17316						
Parquet Flooring Squares	Select and Better smooth-sawn Red and White Oak	5/16" x 6" x 6". SW-B. Spline back; T&G	Unfinished	40	81¢	SS, but not radiant-heated. One page of instructions without diagrams
PREFINISHED PARQUET (selected patterns)—Sykes Flooring Co., Inc., Box 420, Warren, Ark. 71671						
Monticello	Select and Better White or Red Oak	5/16" x 13⅛" x 13⅛". SW; M with SMP. Cotton-mesh back	Prefinished with one coat of penetrating sealer, a curtain coat of varnish, factory waxed and buffed. Light, Antique, or Ravenwood (smooth finish)	31	2.50–3.00	SS. One page of instructions without diagrams
Haddon Hall	Same	5/16" x 13⅛" x 13⅛". SW-HH. Cotton-mesh back	Same	31	2.50–3.00	
Solid Wood Tile Parquet	"Selected grade of oak"	5/16" x 6½" x 6½". SW-B. Spline back	Same	43.5	1.00	
Herringbone	Same	½" x 3" x 9". Laminated oak (three plies of crossgrain hardwood) strips make H, B, and others	Same, plus Antique or Ravenwood with wire-brushed surface	15	2.50–3.00	
HARTCO WOOD FLOR-TILE—Tibbals Flooring Co., Drawer A, Oneida, Tenn. 37841						
	Premium, Natural, and Cabin Oak	5/16" x 12" x 12". SW-SB. Spline back. Temporary glue bond between squares. T&G	Factory-applied penetrating stain sealer, filler, two coats of moisture-cured urethane, waxed and buffed. Olde Brown, Windsor, or Standard	50	1.19–1.29	SS, but not below grade. Two-page instructions with diagram. Color brochure showing step-by-step installation photos available from dealer
HARTCO WOOD FOAM-TILE WITH PAR-K-STIK—Tibbals						
	Same	5/16" x 12" x 12". Same as above with extra backing layer of ⅛" Volara foam cushion (for sound control); treated with adhesive dots and a layer of protective paper. Also available without adhesive for mastic installation	Same	25	1.59–1.69	SS, but not radiant-heated. Comprehensive how-to sound/slide program (including directions for laying flooring around fireplaces and other tricky spots) available through dealers
ARCHITECTURAL HARDWOOD FLOORING (selected patterns)—Wood Mosaic, 5000 Crittenden Dr., Louisville, Ky. 40221						
Brittany	Prime and antique, White or Red oak; choice of other woods	¾" x 28" x 28". Diamond within a square design formed by four squares and four triangles, crossed and bordered by solid slats. Both Brittany and Bordeaux are SW, with a spline back and removable corner fasteners. T&G	Unfinished (specify beveled edges or distressed surface to eliminate sanding problems)	Custom Order	5–7.50	SS, but not below grade. 15-page installation manual with diagrams sent on request
Bordeaux	Same	¾" x 36" x 36". Square within diamond design framed by 20 triangles crossed and bordered by solid slats	Same	Same	5–7.50	
SPECIALTY HARDWOOD FLOORING (selected patterns)—Wood Mosaic						
Singapore Teak	Teak	5/16" x 12" x 12". HH. All Specialty patterns are SW with beveled edges and a choice of webbed back or peel-and-stick adhesive backing	Unfinished or factory-applied—three-step primer, penetrating sealer, and hot-melt wax. Natural or Walnut	25	1.25–2.50	SS, but not below grade. Clear, two-page instructions with step-by-step photo directions, plus series of diagrams showing how to abut carpet to new flooring
Elegante	Brazilian Imbuya Mixed—all light, or all dark wood	5/16" x 12⅜" x 12⅜". SB	Same	25	1.25–2.50	
Checkerboard Teak	Teak	5/16" x 12" x 12". D with SMP	Same	25	1.25–2.50	

[1]Wood grades indicate only the appearance of the wood — clear (select, better, etc.), with "character marks" (cabin), or with surface distressing (antique). All wood grades have the same approximate lifetime. [2]B — block pattern (see below); BW — basketweave; D — domino; H — herringbone; HH — Haddon Hall; M — Monticello; MP — mitered pickets; SB — standard block; SMP — single mitered pickets; SW — solid wood; T&G — tongue and groove. [3]Prices can vary widely, depending on dealer's overhead and shipping costs. Prices do not include cost of mastic or other supplies. [4]SS — Suitable subfloors: clean, dry wood, plywood, firmly bonded tile in good condition, above-grade concrete (on or below grade may require vapor barrier), and radiant-heated concrete slab with temperatures below 85° F.

A few time-tested patterns are combined by parquet manufacturers into a variety of designs. Individual units in the **Block** design, first used in European castles, can have from three to seven wood slats. Four blocks set at right angles make the **Standard Block** design. The **Herringbone** pattern was designed for the Hall of Mirrors at Versailles. Also popular are variations on the **Haddon Hall** pattern first laid in a centuries-old British manor house, and featured in the famous Haddon Hall Hotel in Atlantic City, N.J. **Monticello,** designed by Thomas Jefferson for his Virginia home, is a square bordered by double-mitered or pointed pickets. Spinoffs often have single-mitered (diagonally pointed) pickets. Two newer patterns, the **Basketweave** and **Domino,** complete the basic parquet palette. By varying the grains and colors of the wood that is used, designers can create a variety of looks from these few basic patterns.

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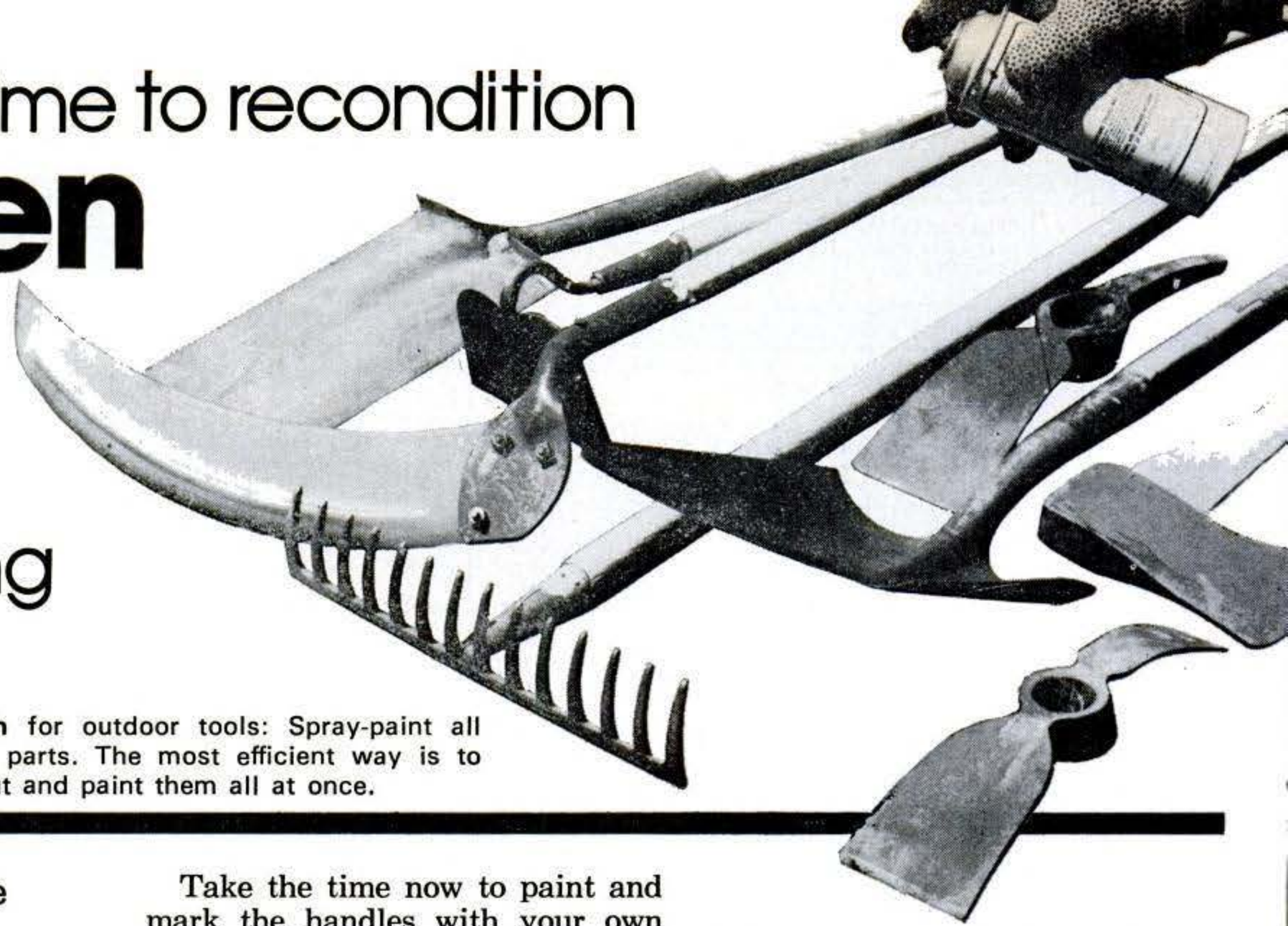
Now's the time to recondition **garden tools** for an active spring



Final touch for outdoor tools: Spray-paint all their metal parts. The most efficient way is to lay them out and paint them all at once.

Repair and maintenance can add years of useful life to your outdoor tools

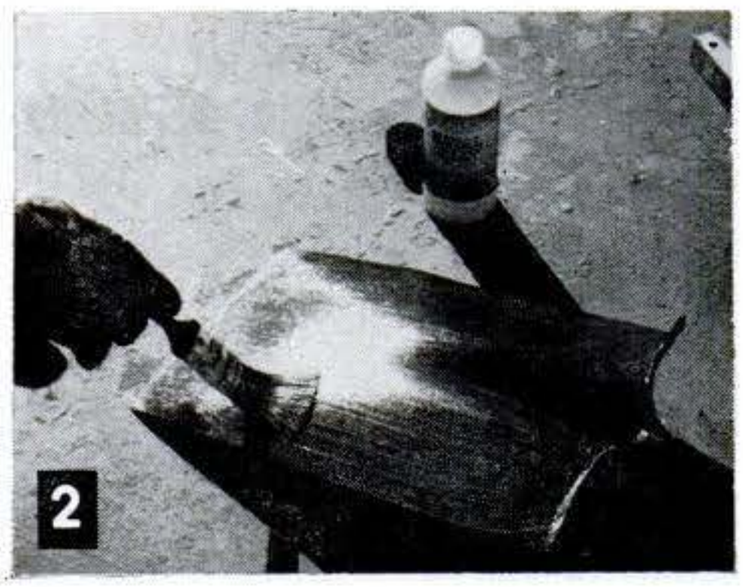
By JOHN ROBINSON

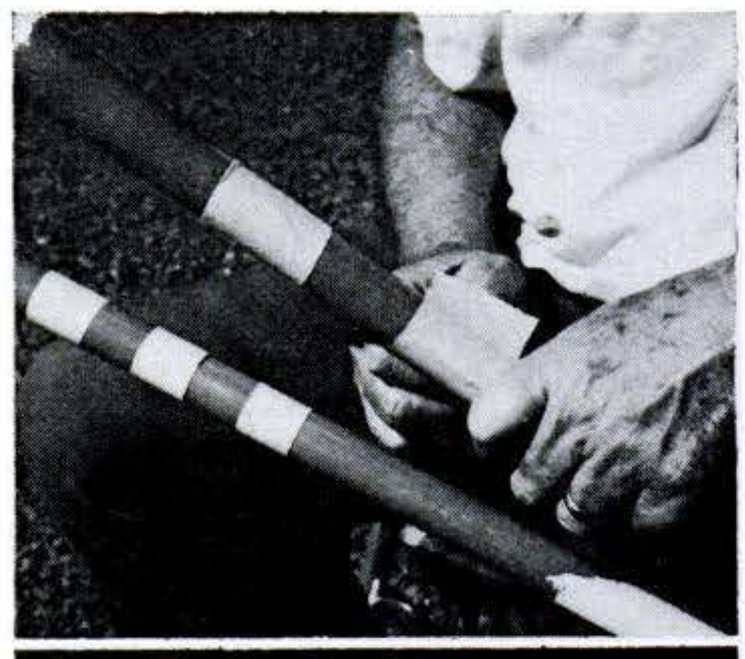
Overhauling your outdoor tools is a dandy basement or garage project for a stormy weekend. Then, when the chores of spring beckon you outdoors, your tools will be ready to go to work with you.

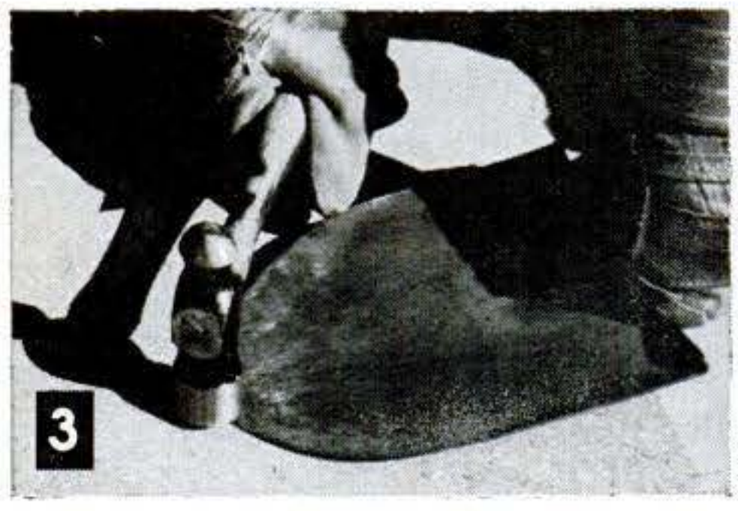
Take the time now to paint and mark the handles with your own color code, and you'll probably end your problems with that neighbor who borrows tools and forgets they aren't his or hers.

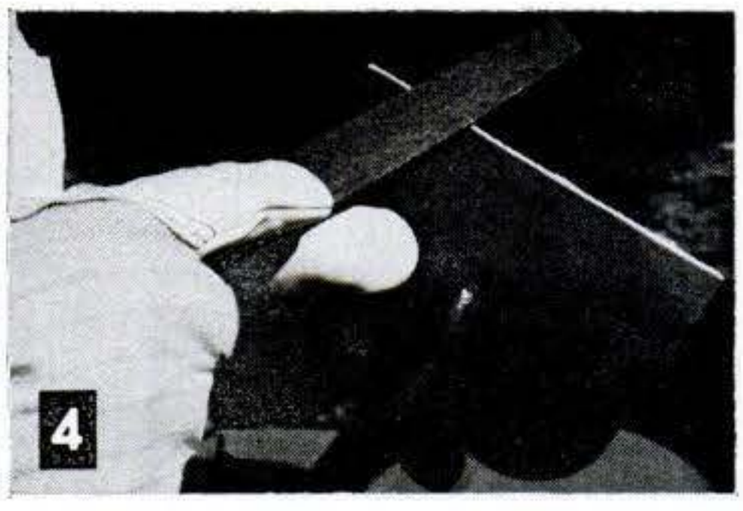
The photos on these pages cover all repair/maintenance procedures —including handle replacement. Most hardware stores carry both types of replacement handle. You'll find they're not cheap, and sometimes it seems you might as well buy a new low-cost tool as buy a new handle. But cheaper tools are often priced low because the maker skimped on the handles. That may explain why you're shopping for a replacement handle in the first place: Tools you've economized on in past years had handles that gave out first. At any rate, it's likely you can improve the quality of any tool with a new ash handle. PS

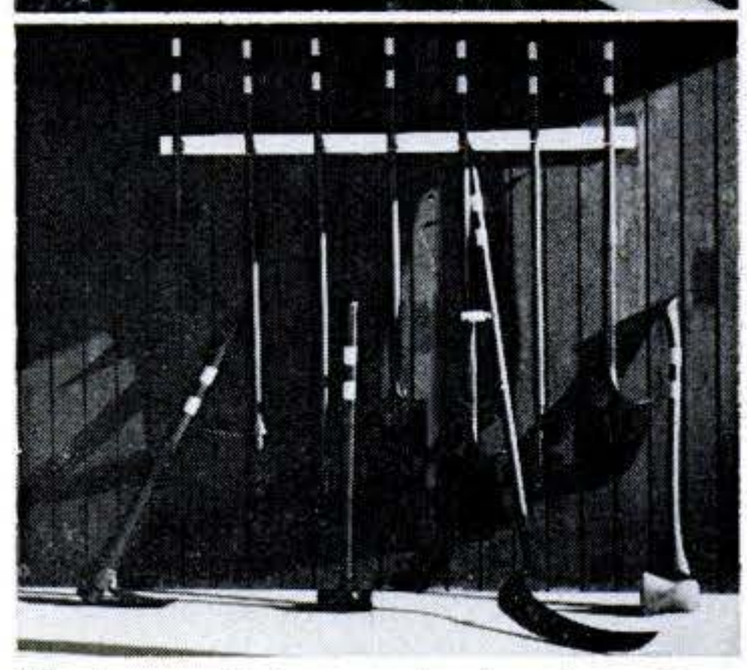
Cleaning, maintaining metal parts











1. Soak digging tools several hours in a bucket of water to loosen caked mud that accumulates after a season of heavy use. After soaking, clean the metal parts thoroughly with stiff brush, or use a wire brush if needed. **2. With metal cleaned and dry,** paint on one of several rust removers that now are available; follow the manufacturers' directions. If the tool is badly rusted, repeat as needed. **3. With the tool on a block of wood,** hammer out any turned-up edges. **4. Sharpen all tools** that need it. Don't worry about painting over cutting edges; these will come clean quickly as the tools are used.

Final step: Paint wooden handles with a good-quality enamel. Masking tape (top) lets you color-code. Then hang tools up (bottom) to keep them organized.

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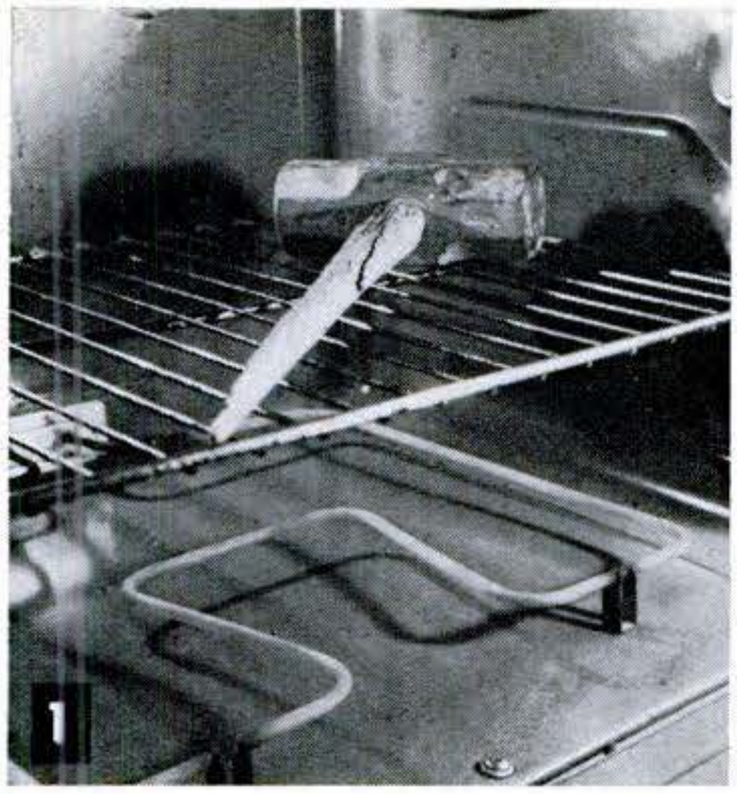
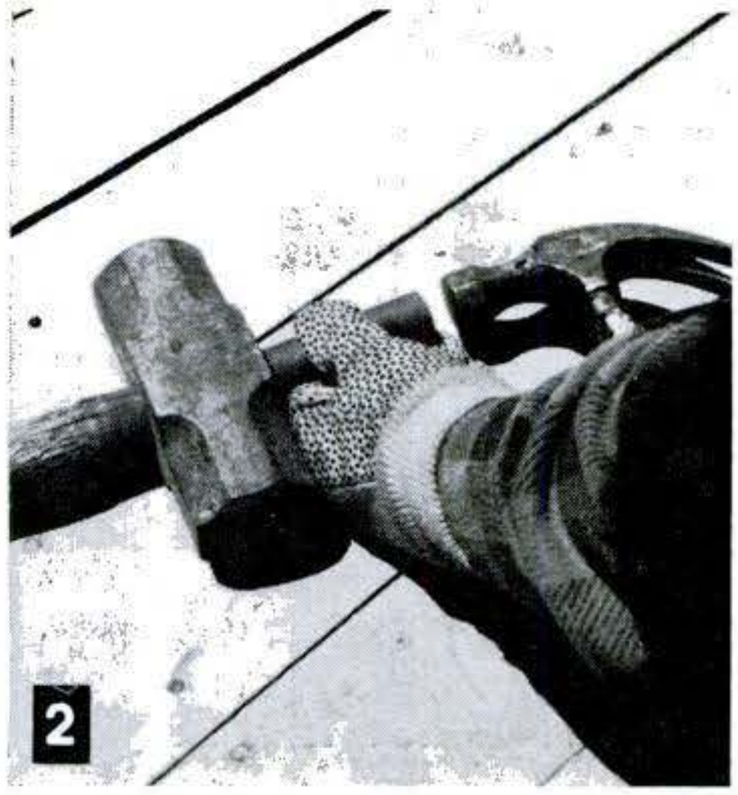
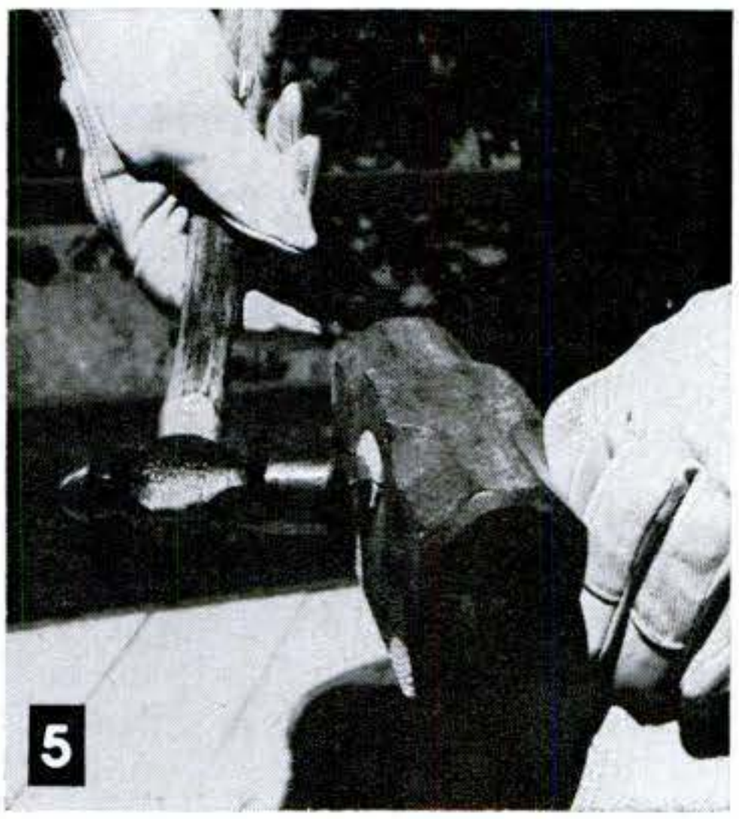
How to replace a through-handle

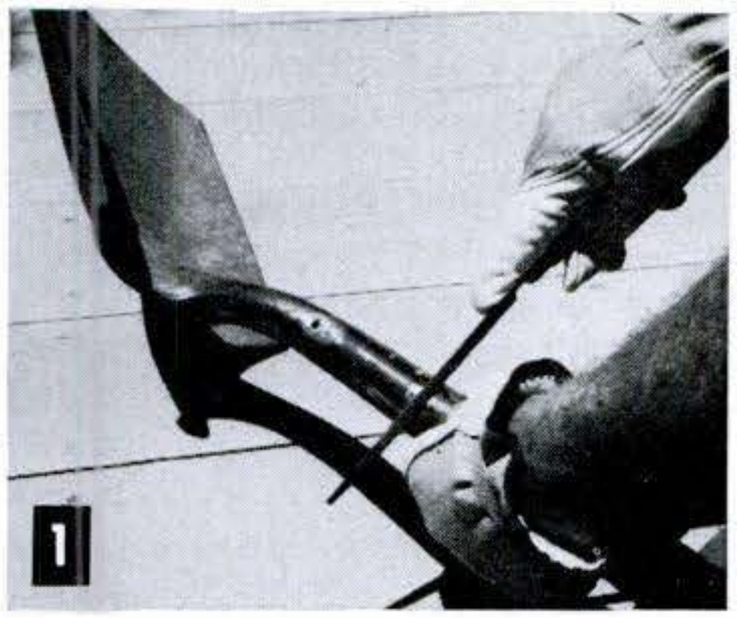


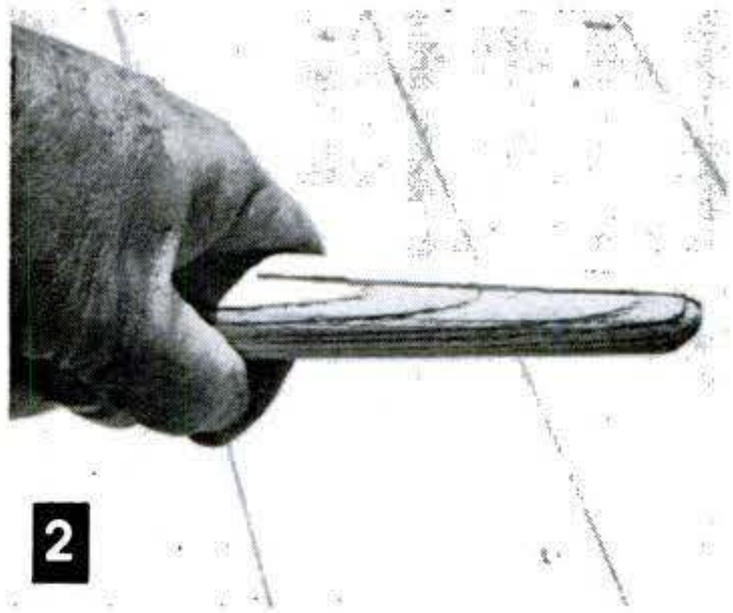


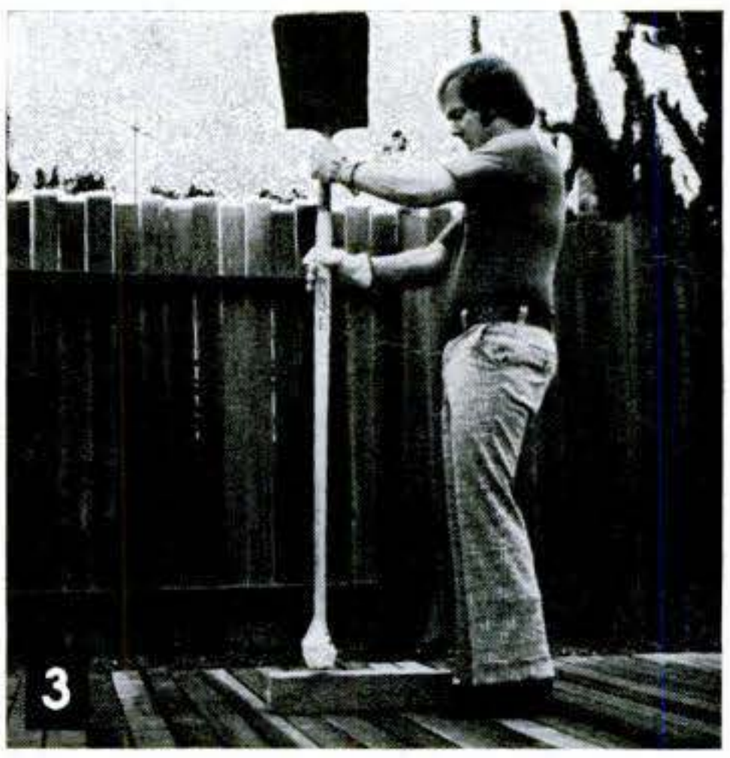


1. If broken handle is too tight to be easily removed, place it in a 300° oven for an hour to shrink the wood. If handle is too long to fit into oven, saw off some. **2. Drive out old handle** with a scrap dowel or pipe. If it won't come out this way, saw off remains of old handle flush with head and drive it out from this side. **3. Compare new handle** with opening in tool to estimate how much must be removed. After the handle is shoved down, it still should be slightly too large. Note wedge taped to handle—a handy refinement from manufacturer. **4. With handle carefully shaped,** drive it through head by pounding upper end of handle on solid substance. **5. Saw off projecting part** of handle before pounding home wedge in slot.

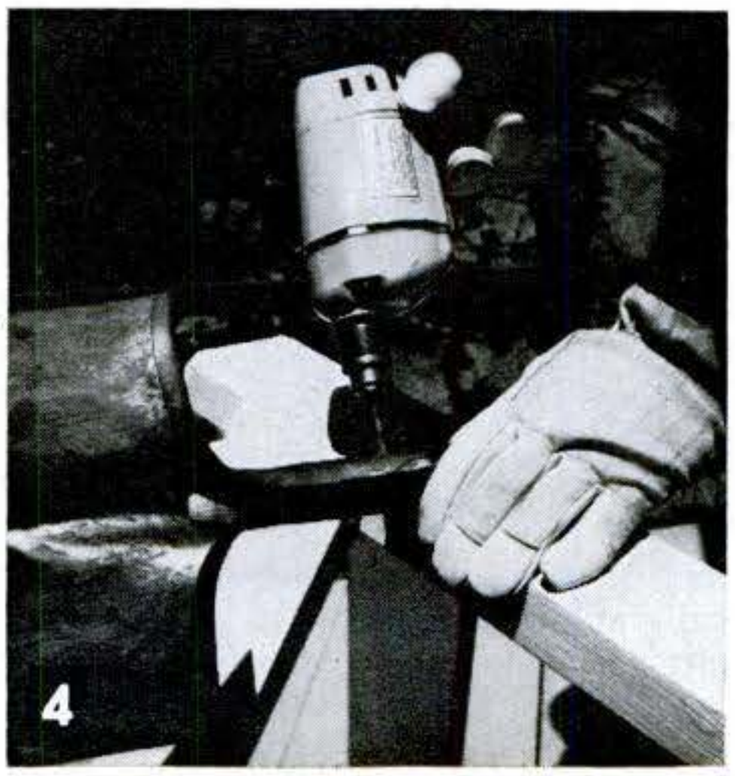
How to replace a socket-handle

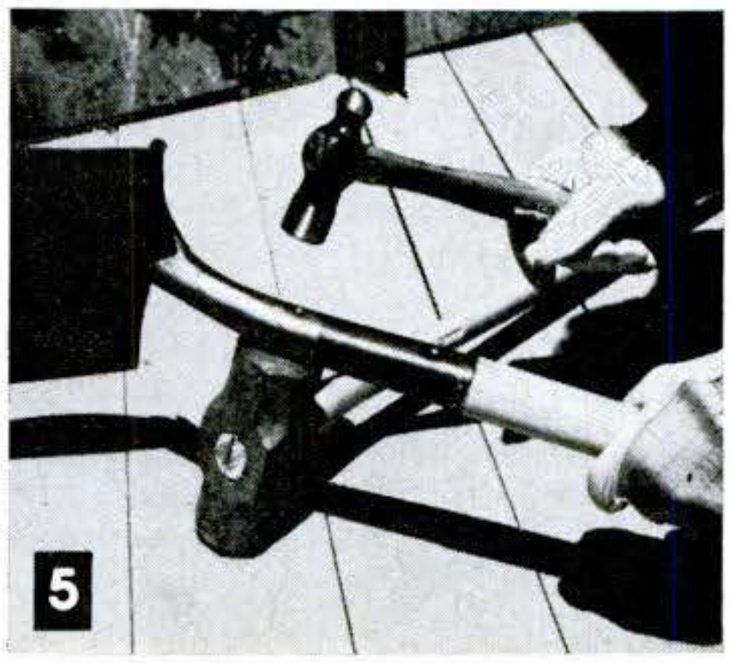






1. For shovels and other "ferrule" type tools, the first step in replacing a handle is rivet removal. Remove either the mushroomed tip or the head of the rivet by filing, then drive out rivet with a punch. **2. When buying new shovel handle,** look for a slit such as this; it allows tip of handle to accommodate curve in ferrule easily. **3. Pounding top of handle** on wood surface drives it into ferrule. If ferrule is oiled, five or six blows should seat handle. Note pad of folded cloth taped to tip of handle to prevent damage. **4. Drill holes for rivets,** going halfway through from each side, then all the way to align and clear the hole. **5. Use the face of a sledge** (or an anvil) to mushroom the rivet against the ferrule by striking the rivet on the head.





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Hooking up a new bath is easier than ever with a **plumbing manifold**

This water-supply control center takes advantage of the flexibility of a new plastic pipe and fittings

By RICHARD DAY

Planning to add a bath, but dread fitting up all that piping? Consider using a plumbing manifold: You make it from newly available tubing and fittings. Once it's assembled, the installation is as simple as plugging tubes into fittings.

A plumbing manifold—a water-supply control center—fits inside the wall of the bathroom it serves. Really two separate manifolds, it holds a cold-water system on one side, with three outlets, and a hot-water system on the other, with two outlets. An access door hides the plumbing. Water comes to the manifold from hot- and cold-water mains, then goes to the fixtures. Valves let you turn off the water handily for repairs or in an emergency.

The job is made easy by new polybutylene (PB) tubing and a series of fittings that mate with it. PB tubing comes in 3/8", 1/2", and 3/4" sizes to carry either hot or cold water. PB tubing is so flexible it can be threaded through walls, floors, and ceilings like electrical cable. It's NSF-approved for drinking water, accepted by the FHA, and conforms to ASTM D3309. PB has been okayed by some building codes.

Cut with a knife and stabbed into a fitting, PB tubing gets a hand nut tightened around it for a watertight, pullout-proof connection [see "Plastic Fittings Make Plumbing a Cinch," PS, Aug. '76]. While the connection is permanent, it can be disassembled and reconnected.

The plumbing manifold itself consists of an array of CPVC (chlorinated polyvinylchloride) fittings. These solvent-weld to each other and connect to PB tubing with adapters. Most everything you'll need for the manifold is made by Genova, Inc., and can be purchased in most well-stocked hardware/home centers.

The idea for a residential plumbing manifold started with a unique fitting called the stackable T—pioneered by Genova for fast, easy plumbing installations in underdeveloped nations. One end of the stackable T solvent-welds inside the next stackable T or to other 1/2" CPVC tubes and fittings. The T feeds a 3/8" PB tube through a stab-in connection, which is part of the fitting. The PB tube leads to a lavatory or toilet.

I mocked up two manifolds (see photos at right):

The two-valve version has hot- and cold-water control. This provides for fast shutoff of the entire bath in an emergency. The five-valve version features individual-fixture control on both hot- and cold-water sides.

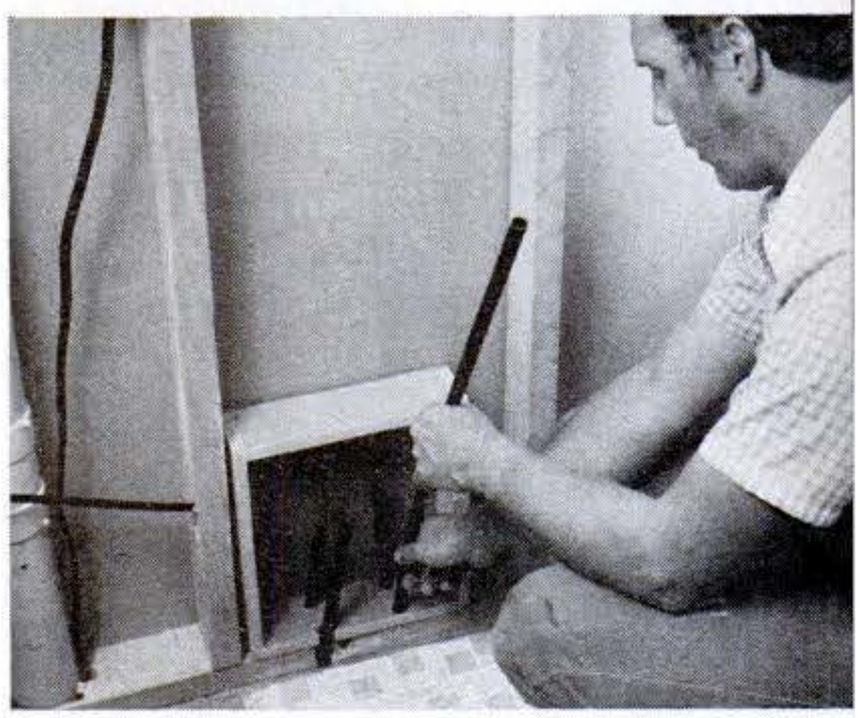
For the add-on-bath installation shown here, I chose the five-valver because it offers complete water control. Its cost (exclusive of hook-up tubing) came to $33.95. For a bit less—$29.97, to be exact—you can build the two-valve model. It's the one that uses stackable T's; the five-valve is a hybrid.

Complete with 100 feet of PB tubing and all fittings needed to hook it up, the manifold supply system costs just over $100.

How deep you make the manifold enclosure depends on what you want in it. The two-valve version

Continued

Flexible polybutylene tubes go practically wherever you want them, with fittings needed only at ends of runs. Prototype PB was black; Genova now makes it in beige, similar to CPVC.



First bring larger 1/2" PB tubes into the manifold. One pair carries hot and cold water from house mains, the other leads to tub or shower. Crawl-space installation here feeds from below.

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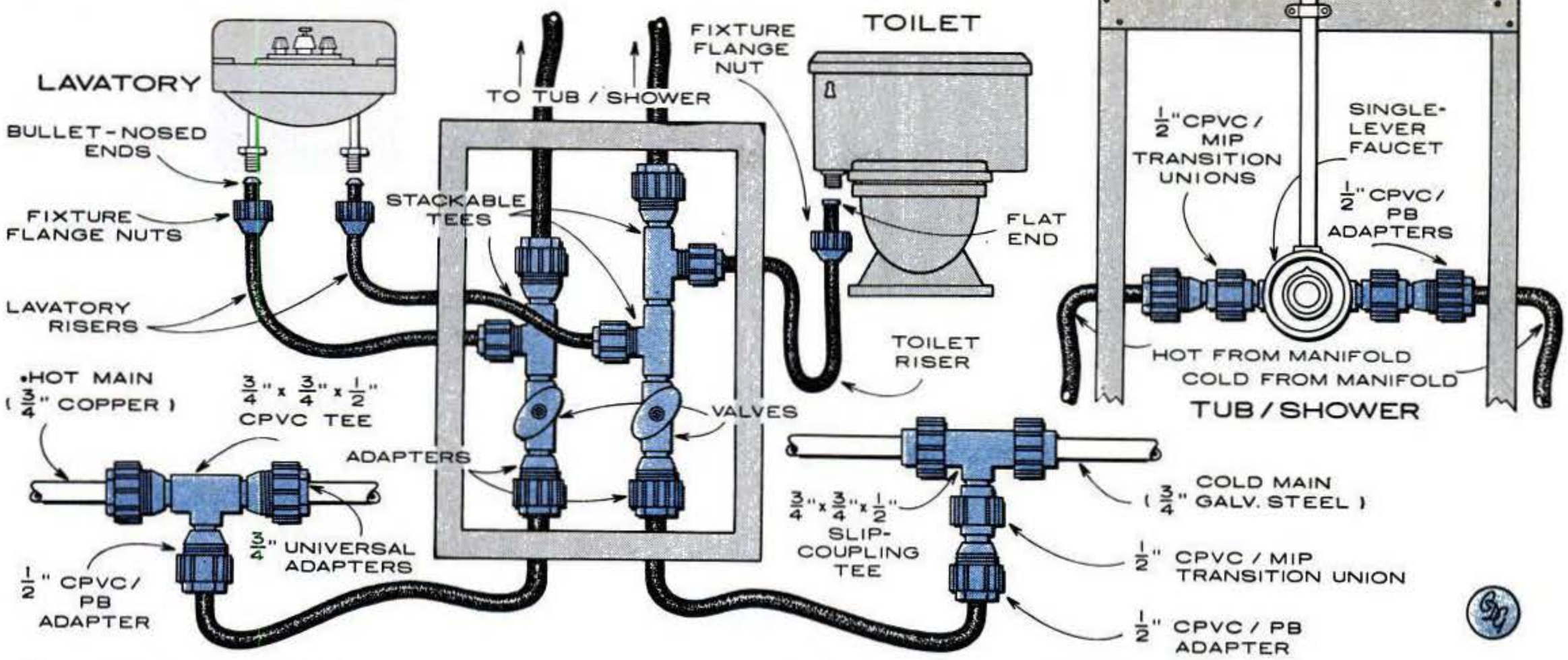
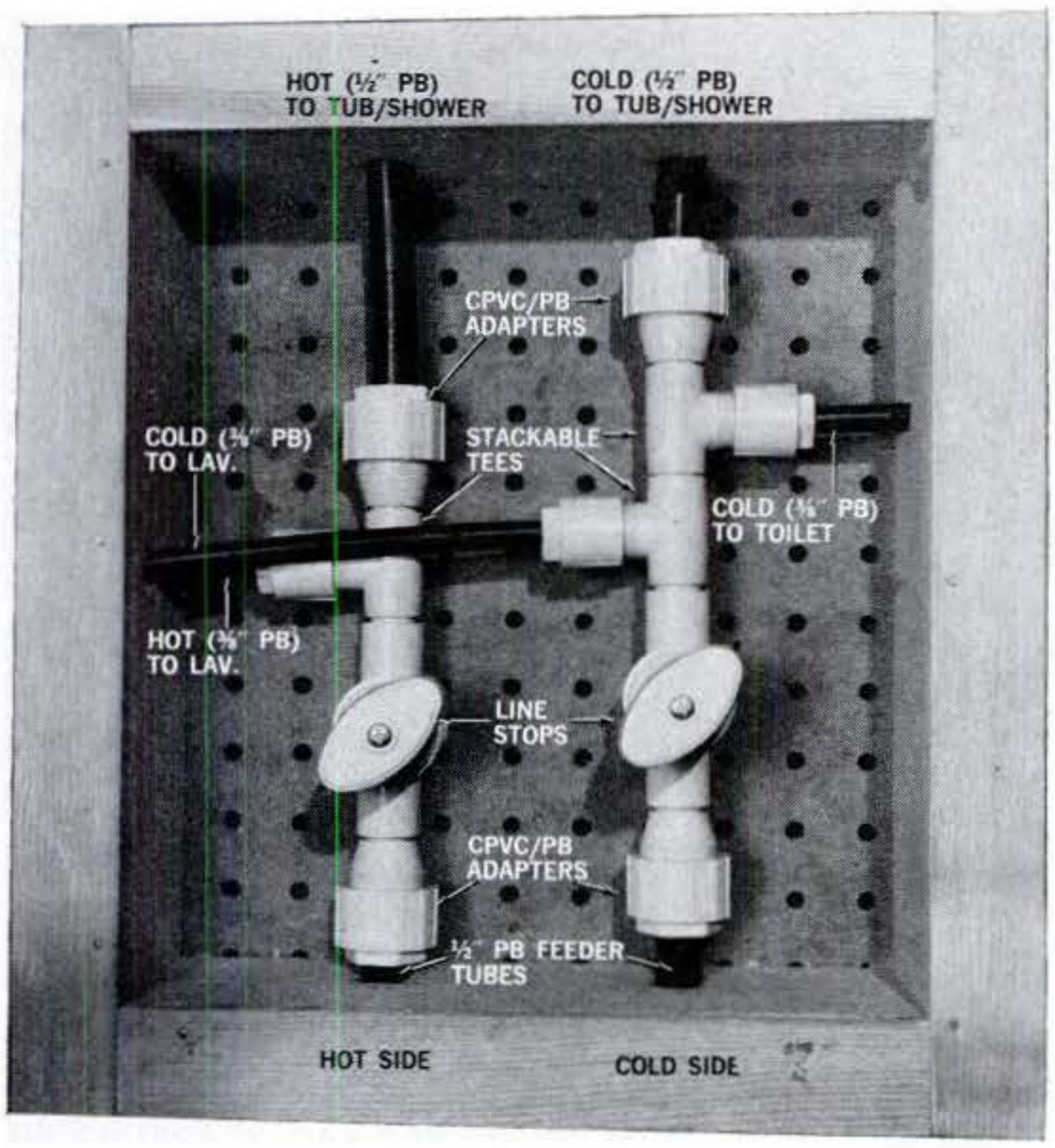
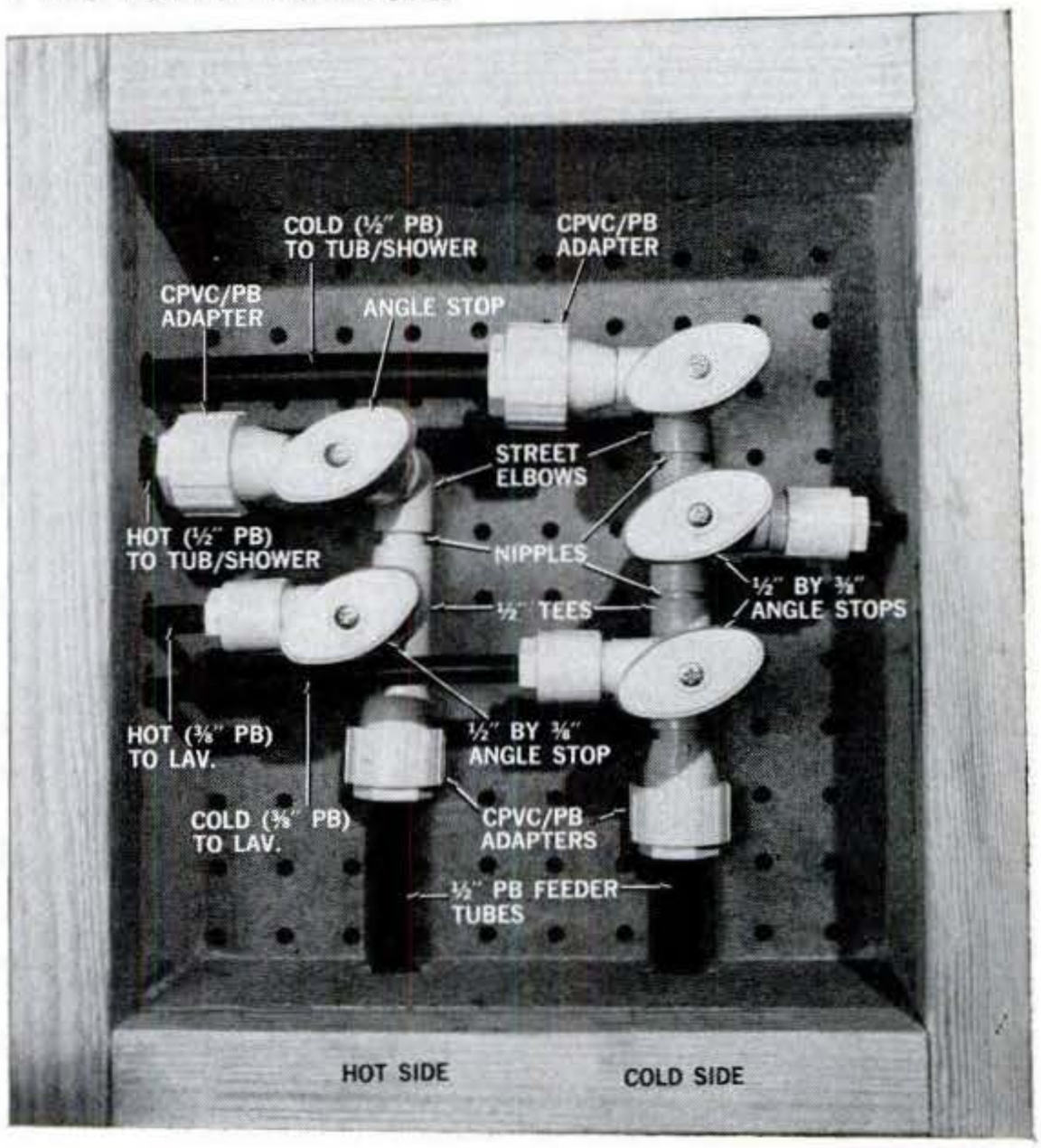
Complete system, from mains to fixtures

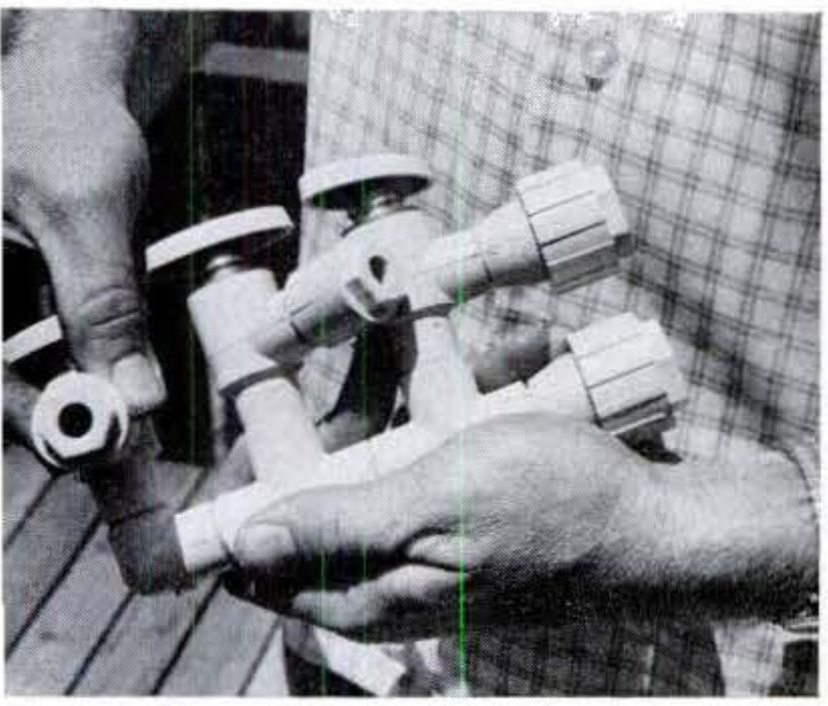


Two-valve manifold

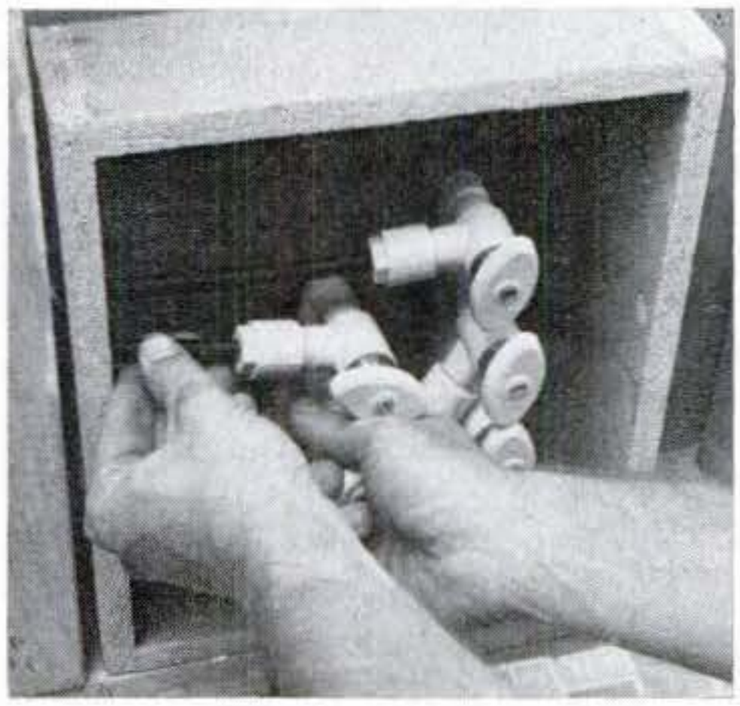


Five-valve manifold

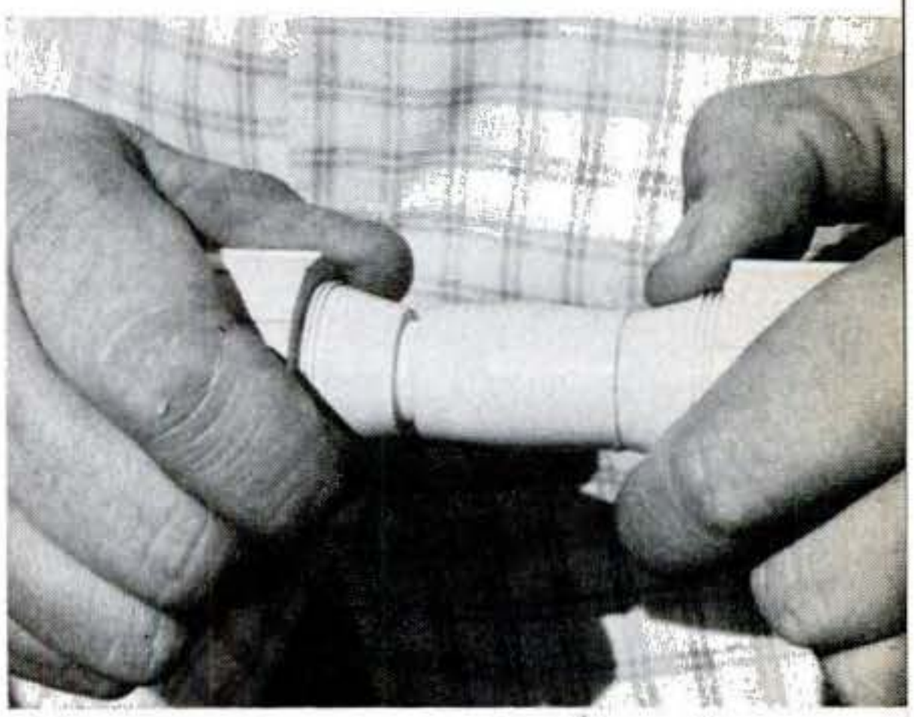




Author solvent-welded his manifold parts on site to permit custom-aiming of some fittings. Male and female parts are doped with primer, then solvent. Assembly is quick, with a slight twist.



Install 3/8" supply tubes last because they're more flexible, stabbing them in and tightening. The hot and cold manifolds may now be secured to the back panel of the enclosure.



Joining two lengths of PB tubing with a coupling or elbow is done with a pair of CPVC/PB adapters solvent-welded to the selected fitting. Hold assembly together while the solvent sets.

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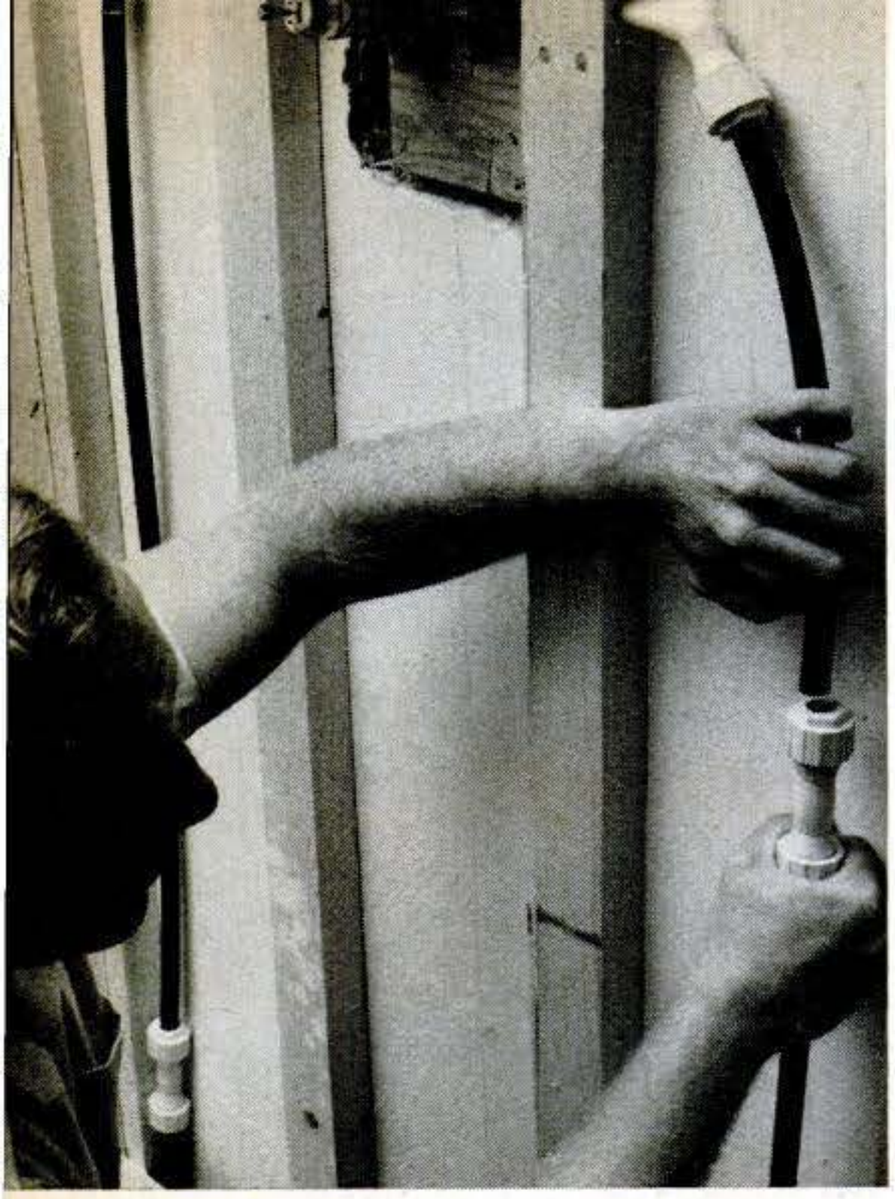
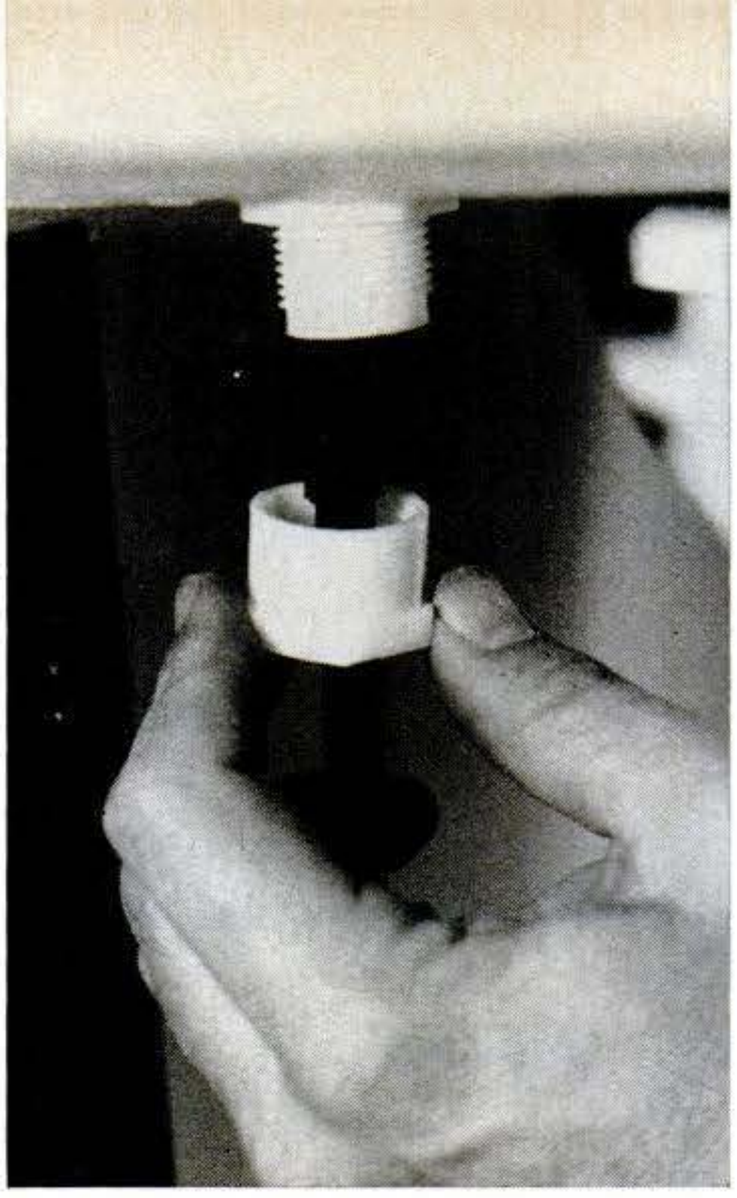


Solvent-welded CPVC/PB adapter is pushed over the ends of the tubing, and the nuts are tightened. Author made four 10-ft. lengths of polybutylene tubing do the entire job.



At the toilet, the ⅜″ Genova riser connects to the inlet-valve opening with a fixture flange nut. (The nut comes with most toilets.) Wrench-tightened, this joint should be watertight.

Hooking riser tubes to lavatory is a little tougher because you're working underneath. Plumber's method is to use a basin wrench. With patience ,however, you can use an ordinary wrench.

fits neatly inside a standard 2-by-4-inch stud wall, and trims out flush. The five-valver needs a box five inches deep that extends about an inch from the wall. I made this in two pieces: a 3½″ box, plus a 1½″ frame. I dadoed the frame members in back so they'd overlap the finish wall, hiding all raw edges of the cut-out. A ⅛″ plywood door hinges to the frame.

My original plan was to prebuild the manifold, solvent-welding its parts and strapping them to wood blocks inside the enclosure. Holes for pipes would have been predrilled in the enclosure's top, bottom, and sides.

I-of-little-faith feared problems in hookup, and so decided to dry-assemble the manifold components, solvent-welding them only after checking for fit at the site. This allowed each fitting to be custom-adjusted. In tight quarters I'd recommend custom-fitting; otherwise, you'll be as well off prebuilding.

Manifold location

Nail the manifold enclosure to wall framing in a convenient location. To use standard-length ⅜″-by-36″ PB lavatory riser tubes, you want the manifold as close to the lavatory faucet as practical.

Location of the manifold can also affect water flow. You'll get good flow to toilet and lavatory—all they can take—if the length of ⅜″ supply tube is 10 feet or less. At 50-psi house water pressure, this supplies 3.2 gallons per minute (gpm) hot and cold water. That's enough for a shower, too, but not sufficient for a bathtub or kitchen sink. A tub and sink should provide five gpm on each side. If it is shorter than four feet, a ⅜″ supply tube will provide that flow; otherwise, you'll have to supply a sink or tub with ½″ PB tubing, as we did. The larger ½″ tubing permits a five-gpm flow with most length.

Lavatory riser tubes come with bullet-nosed ends that fit most lavatory-faucet tailpieces directly. A ⅜″ fixture flange nut holds them tightly into the tailpiece.

The flat end of a toilet riser tube fits the bottom of the toilet's inlet valve [see "Poly Riser Tubes for Weekend Plumbers," PS, Sept. '75]. Again, a ⅜″ fixture flange nut does the job.

If you prefer, you can substitute regular ⅜″ PB tubing for the factory-made risers. This allows you to reach out any distance within reason from your manifold to connect the lavatory and toilet water supplies. The tubing doesn't have preformed ends, so you'll have to make your own connections at the fixtures. You can do this with ⅜″ soft-rubber ferrules and fixture flange nuts. Tightened down, these produce leak-free seals around the PB tubing ends. Use friction rings between the nuts and ferrules.

Location selected and manifold mounted, the next step is to run the ½″ PB manifold feeder tubes. These extend from nearby hot and cold water mains to the manifold.

Most house mains are ¾″ sweat-soldered copper or threaded galvanized-steel pipes. If they're copper, saw out a 4¼″ length and adapt to the cut-off ends with push-on (such as Genova 530951) universal adapters with stainless-steel grab rings. These solvent-weld directly into a ½″ CPVC reducing T (51471). Then solvent-weld a CPVC/PB adapter (530751) into the ½″ T, and you're off and running with flexible ½″ PB tubing. You thus avoid risky torch-soldering while your house water supply is turned off. Of course, you can solder in a ¾″ copper reducing T, adapt to CPVC, then to PB. This would be less expensive because fewer parts would be used.

The simplest way to connect to threaded galvanized or brass water mains is by using a slip-coupled adapter T. These come in metal or plastic. Use metal for hot water. Get the ¾″-by-¾″-by-½″ reducing version and save buying a reducing bushing. Just saw out short lengths of both the hot- and cold-water mains and slip on the adapters. Tighten the jamb nuts. Then you can screw ½″ CPVC/MIP transition unions (530451) into the adapter branches. Solvent-weld ½″ CPVC/PB adapters (530751) to them and continue with ½″ PB.

If you do the job any other way, you'd have to thread the cut-off ends of the metal pipes. Be sure to use pipe dope or Teflon plumber's tape on all pipe threads before making up the joints.

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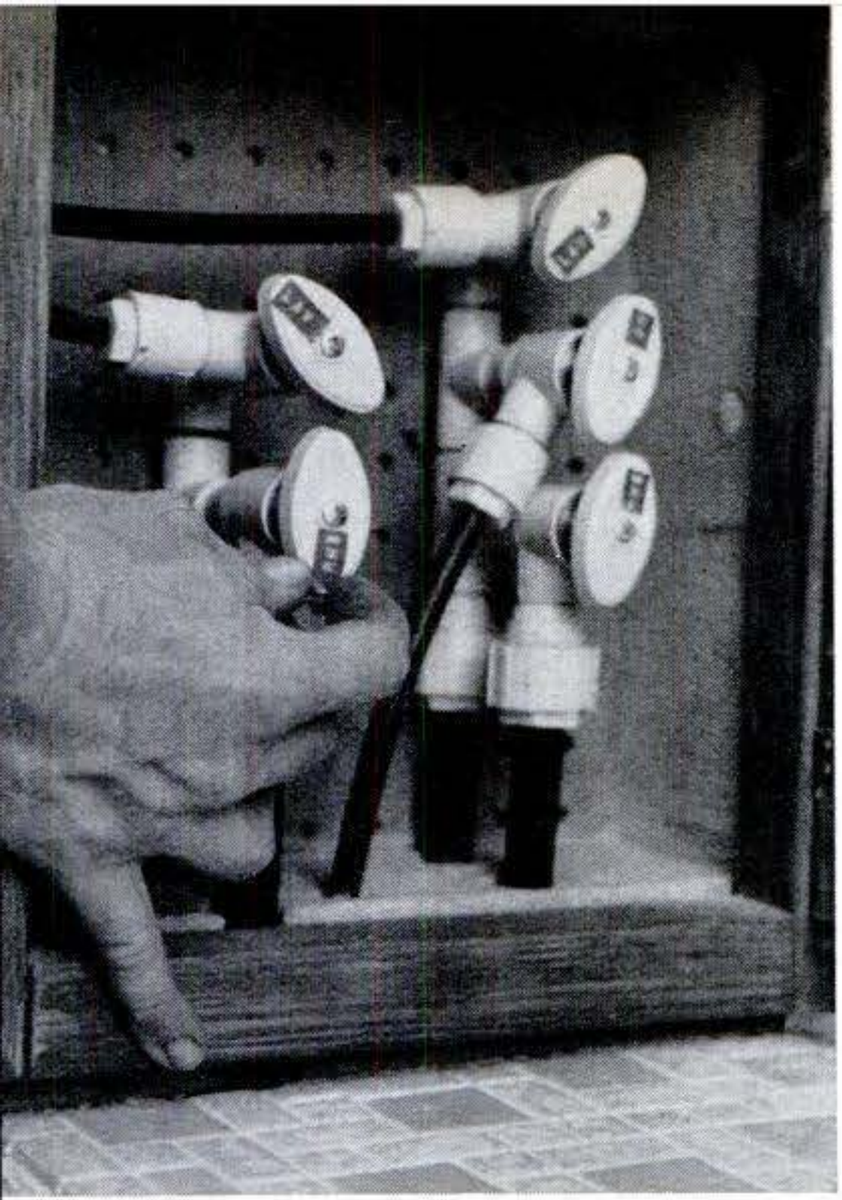

As a finishing touch, you can identify each valve's function with labeling tape stuck on the handle. This would help in an emergency. Abbreviate so you can fit tape on space available.

One other caution: Use transition unions, not plain adapters. Male or female adapters between metal and vinyl pipes carrying anything but cold water tend to crack. The specially designed transition unions compensate for differences in thermal expansion between metal and vinyl. Don't try to substitute ordinary PVC fittings for CPVC, either. PVC won't take hot water for very long.

At the plumbing manifold, the PB feeder pipes are inserted into CPVC/PB adapters. To help them go in, chamfer the pipe ends all around and lightly smear some petroleum jelly on the O rings. Plugged in about 1½ inches, the pipes bottom out inside the fittings.

Working in the confines of the manifold, I found it just as easy to make connections by taking apart the ½" adapters. Then I slid the hand nut over the tube end, followed by the split grab ring, thrust collar, and finally the O ring. (This is the sequence they share inside the adapter.) Finally, I inserted the PB tube into the adapter until it bottomed out on the shoulder inside, engaged the hand nut, and hand-tightened it.

Runs to the fixtures

Supply tubes to the tub-shower connect just as the other manifold tubes. Chamfer the ends, lubricate, and stab in, then hand-tighten. If you use ½" tub/shower supply tubes, as I did, the faucet connection at the fixture takes you from PB to a ½" CPVC/PB adapter (530751), then to a solvent-welded CPVC/MIP steel transition union (530451). This screws right into the ½" female-fixture supply opening. For sweat-soldered tub/shower valves use a CPVC/SWT copper transition union (530201) and a short ½" copper nipple.

Since water pressure is minimal at the shower head, you can dispense with the transition union at the shower valve and use a simpler 50405 male-threaded adapter to start the run to the shower head. A length of ½" CPVC tubing reaches up to a CPVC wing elbow (530551) into which threads the standard chrome shower arm. Put some silicone-rubber sealant on all threads before screwing them in.

Install the ⅜" lavatory-toilet-supply tubes last because they're more flexible than the ½" tubing. Be careful with escutcheons, though. If you connect the supply tubes and *then* try to put up the finish wall, the huge holes you'll have to make to pass the escutcheons won't be covered by them. To prevent that, let the supply tubes hang out of the wall framing without escutcheons. Then when you install the finish wall, drill each panel large enough to pass the tube and fixture flange nuts at each location. About one-inch holes should do it. As you fit up a panel, fish the nuts and tubes through the holes. The holes may be hidden with split escutcheons; make them by slitting vinyl escutcheons (530121) with a sharp knife; then slip them on.

Supply tubes should be fastened to crosspieces behind the wall at the proper height for lavatory and toilet. Set the lavatory's tubes 22 inches above the floor and eight inches on center behind the basin. Set the toilet's supply tube six inches high and eight inches to the left of the toilet's centerline (as you face it). This brings all supply tubes out of the wall at right angles so their escutcheons will fit neatly against the wall.

If your lavatory faucets have copper-tube tailpieces—as many do—connect them by flaring the ends of both the copper and the PB tubing. Then make the connections with flare couplings. Yes, PB can be flared.

PB will bend easily and is tough to kink, but don't make your bends too tight. The minimum bending radius of ½" tube is four inches. Smaller ⅜" tubing can be bent 90° inside a stud wall to exit without strain. Its minimum bend is to a two-inch radius. If you need tighter bends, adapt PB to a CPVC elbow and back again to PB.

Support horizontal runs of PB tubing every 32 inches with nonmetallic tubing straps that permit end-wise thermal movement. As with all but threaded steel and brass piping, protect PB tubing runs from puncture by nails. Steel straps nailed to the framing over tube crossings will do.

Flow-through manifolds

Flow-through design may be added to both of the plumbing manifolds we show, simply by installing another pair of hot/cold outlets. The parts required are included in the list below. A flow-through manifold might supply another manifold in an adjoining bathroom or a kitchen sink beyond the manifold.

You can create any number of other plumbing-manifold designs. Like the tubing used to connect it, a manifold system is flexible. PS

MATERIALS REQUIRED

Manifold part	Catalog no.	Two-valve	Five-valve
Stackable T's, ½"CPVCx⅜"PB	530051	3	
Line stops, ¾"x½"	530151	2	
Angle stops, ½"CPVCx⅜"PB	530651		3
Angle stops, ½"	530661		2
CPVC/PB adapters, ½"	530751	4	4
CPVC T's ½"	51405		3
CPVC 90° street elbows, ½" (not req. for flow-thru design)	52095		2
CPVC nipples, ½"x1½"	*		3
#1 Novaclean primer, ¼ pt.	14010	1	1
#2 Novaweld solvent, ¼ pt.	14110	1	1
Add for flow-through design			
CPVC T's ½"	51405	2	2
CPVC nipples, ½"x1½"	*	2	2
CPVC/PB adapters, ½"	530751	2	2
Add for piping and hookup			
PB tubing, ½"x100' coil	53421	1	1
CPVC tubing, ½"x10'	50005	1	1
PB lav riser tubes, ⅜"x36"	530881	1 pr.	1 pr.
PB toilet riser, ⅜"x20"	530821	1	1
CPVC/PB adapters, ½"	530751	4	4
CPVC T's ¾"x¾"x½"	51471	2	2
CPVC/copper universal adapters, ¾"	530951	4†	4†
No-threading adapter T's, ¾"x½"	*	2††	2††
CPVC/MIP steel transition unions, ½"	530451	2††	2††
CPVC/MIP steel transition unions, ½"	530451	2††	2††
(or alternate)	530201		
CPVC/MIP male adapter, ½"	50405	1	1
CPVC wing elbow, ½"	530551	1	1
Fixture flange nuts, ⅜"	*	3	3
CPVC/PB tubing straps, ½" bag,	52105	1	1
Escutcheons, ⅜"	530121	3	3

*Cut from ½" CPVC pipe. †Sweat-soldered copper only. ††Galvanized steel only.

Part numbers shown are for Genova (7034 E. Court St., Davison, Mich. 48423).

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How to work with plywood

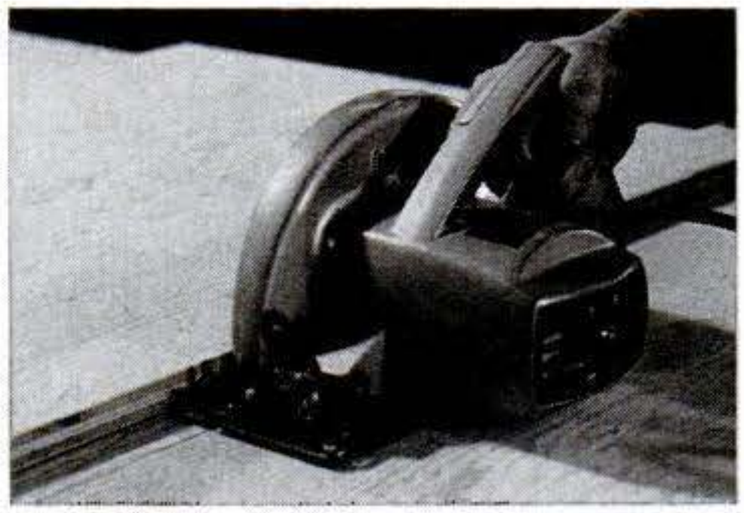
Last call for single-sheet projects that can win you $1000 (page 126). Here are tips for cutting, assembling, and finishing plywood

By AL LEES

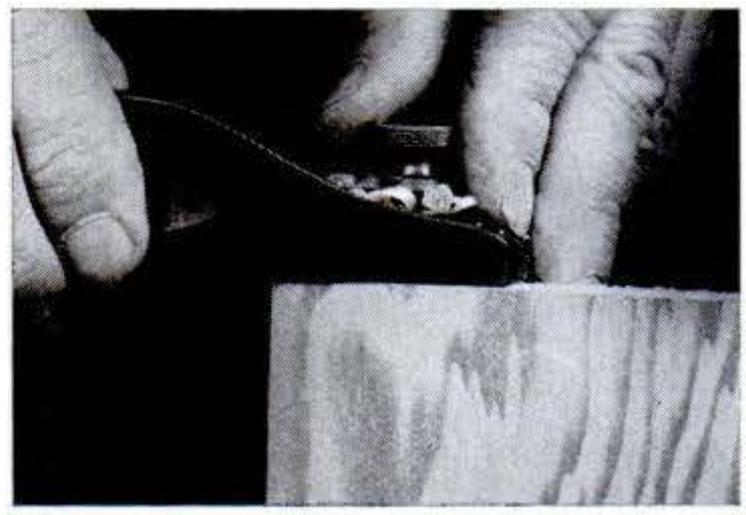
Whether you're building a potting bench or a picnic table, you'll find plywood an economical, versatile material. It's strong, rigid, and light—and it can be worked easily with common carpentry tools. It offers a full range of finishing options: It can be painted, stained, or covered with plastic laminates, tile, or other surfacing materials.

Before you start, plan how you'll cut the 4-by-8 panel. By first sketching your project pieces on a sheet of paper, you'll be able to study how the plywood can be used most efficiently. And you can ensure that long, narrow pieces will be cut with the grain. Remember to plan the cutting layout so you can quickly reduce the panel to sev-

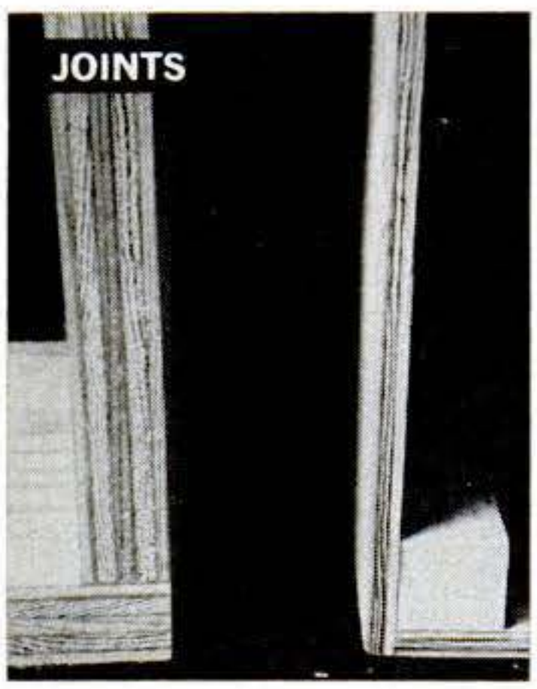
On table saws, as with hand-sawing, keep good face up. Use sharp combination blade or fine-tooth plywood type; let it project above panel height of teeth.



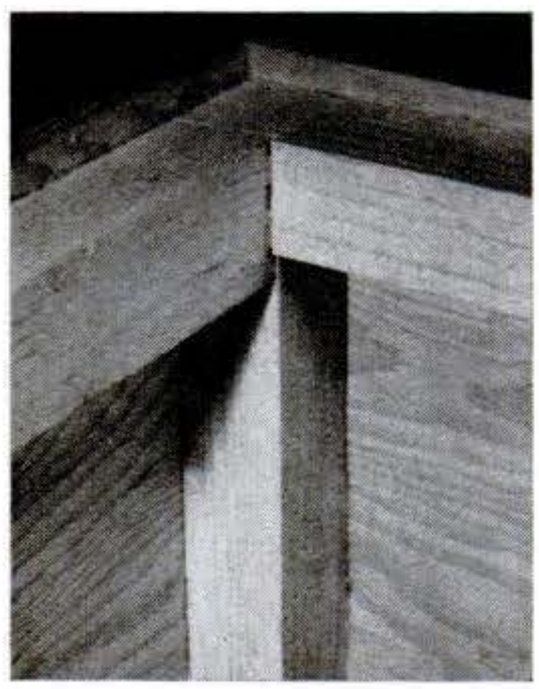
With portable circular saws, cut with good face down. For straight cut, clamp scrap strip parallel to line. Fine-tooth blade with minimum set is best choice.



Plane from corners. If you plane from center outward, you'll split out plies. Use sharp blade set for shallow cut. Sharp saw often lets you skip planing.

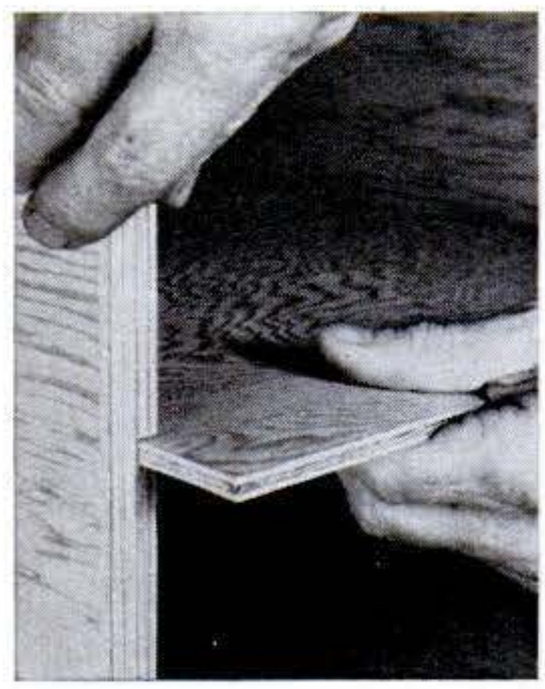


Butt joint can be used with ¾″ or thicker panels. Thinner plywood (right) calls for reinforcing block. Glue makes any butt joint much stronger than nails alone.



Frame construction gives superior strength at minimum weight, since you can cover frame (2-by-2's in photo above) with ½″ or thinner panels.

Rabbet joints are neater and stronger than butt, offer greater gluing surface, expose fewer plies. They're trickier to measure for, cut (power tools do best), and assemble.



Dado joints are ideal for partitions and shelves, which can be slip-fitted, left unglued for adjustment. Cut dadoes with a circular saw, using a dado head.

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eral smaller pieces, using either a hand crosscut or a power circular saw. Between adjacent pieces, allow for the width of a saw kerf.

Which side of the plywood panel you mark for cutting will be determined by the saw you'll use. You're using a handsaw or a table power saw? Then mark and cut on the better-looking face. If you're using a portable circular saw, it's the reverse: Cut with the good face down.

Before you start to cut, check your blades. They're sharp? That means a smooth cut and less chance of splintering. As an additional prevention, clamp scrap lumber under the cut. If that's clumsy, run a strip of masking tape along the line of cut, and saw through it.

For handsawing, use a 10- to 15-point crosscut; a fine-toothed keyhole or coping saw is the best for curves. With a circular saw, the plywood blade is preferred, but a combination cross-cut and rip blade can also be used. For curves, use a saber saw, jigsaw, or bandsaw—again with a fine-toothed blade.

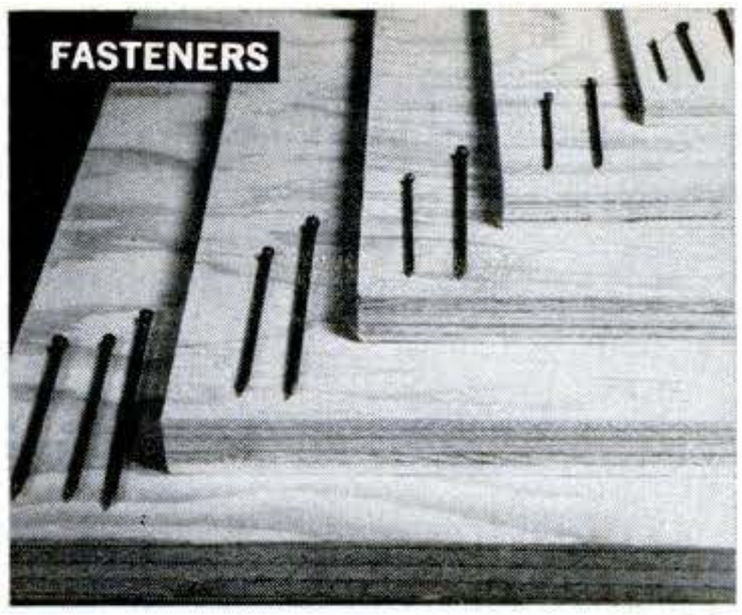
When you're drilling, support your panel well. When the point of the bit appears through the plywood, flip the panel and complete the hole from the back.

If you're working with MDO plywood, it's even more important to keep tools sharp. Always saw and drill into the coated face of the panel, not from the rear. (If your panel is MDO-coated on both faces, work from the face you select as the most critical.)

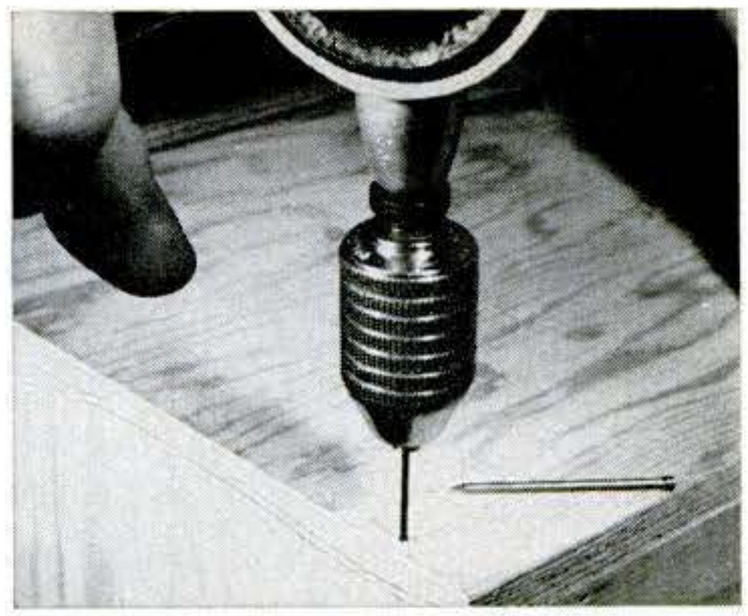
Most appearance-grade plywood is sanded smooth in manufacture, so little sanding will be needed on the faces. Before applying a sealer or undercoat, use a 1-0 (80 grit) or finer sandpaper. After sealing, use 3-0 (120 grit) sandpaper, sanding only with the grain. To prevent gouging, use a sanding block.

Wood putty is an easy-to-use filler for exposed plywood edges that will be painted. You can buy a prepared putty that's ready to

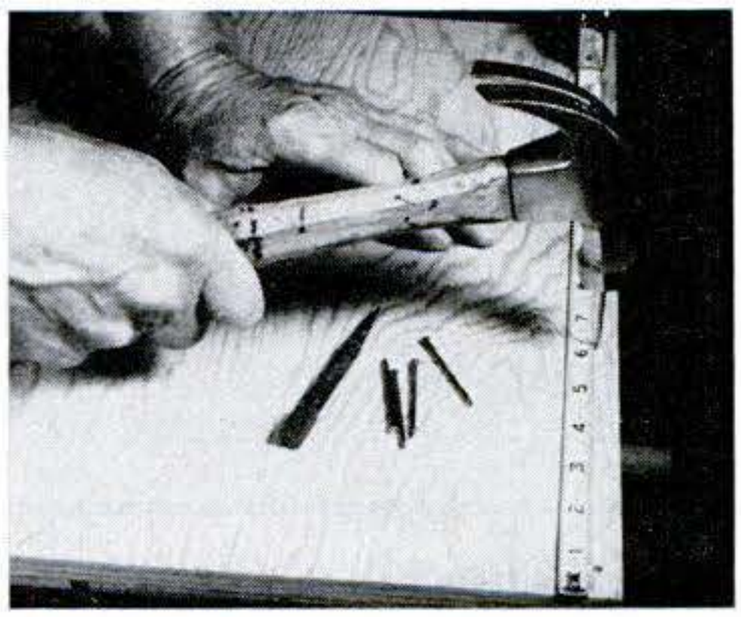
Continued



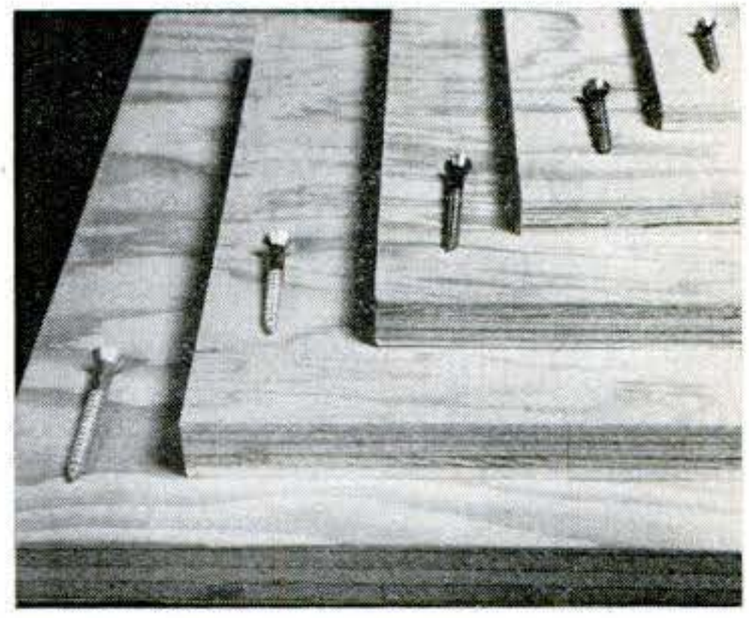
Nail size to use depends on panel thickness. From left: 6d casing or 8d finish for both ¾" and ⅝"; 4d or 6d for ½"; 3d or 4d for ⅜", 1" brads for ¼".



Predrilling is best when nails must be very close to edge, though plywood will split much less than lumber. Use a bit of slightly smaller diameter than nail.



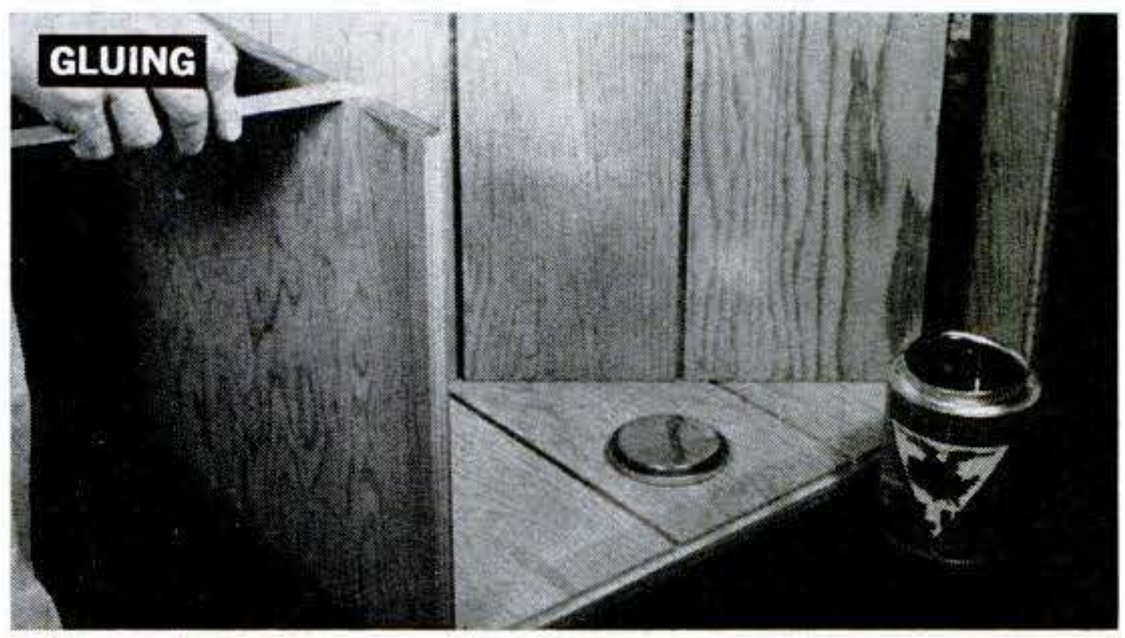
Space nails about 6" apart when assembling most glue joints. With thin ply, if there's buckling between, space nails closer or use headed type (lath nails).



Screws give stronger joints, but heads are harder to hide. Sizes in chart below are minimums; use longer screws if work allows, soap threads to ease drive.

PLYWOOD THICKNESS	SCREW LENGTH	SCREW SIZE	DRILL SIZE FOR SHANK	DRILL SIZE FOR ROOT OF THREAD*
3/4" 5/8"	1½" 1¼"	#8	11/64"	1/8"
1/2" 3/8"	1¼" 1"	#6	9/64"	3/32"
1/4"	1"	#4	7/64"	1/16"

*If splitting is a problem (as in edges), make hole for threaded portion 1/64" larger (9/64", 7/64", and 5/64" respectively).



Choose right glue for your project from chart below. Before you apply, dry-assemble joint to be sure panels make contact at all points. Apply glue with flat stick—in two light coats a few minutes apart to let end grains absorb first coat. Avoid excess if project is to have natural finish.

TYPE OF GLUE	DESCRIPTION	RECOMMENDED USE	DISADVANTAGES	HOW TO USE
UREA RESIN GLUE	Comes as powder to be mixed with water and used within 4 hours. Light colored. Very strong if joint fits well.	Good for general wood gluing. First choice for work that must stand some exposure to dampness, since it is moisture-resistant.	Needs well-fitted joints, tight clamping, and room temperature 70 or warmer.	Make sure joint fits tightly. Mix glue and apply thin coat. Allow 16 hours' drying time.
LIQUID RESIN (WHITE) GLUE	Comes ready to use at any temperature. Clean-working, quick-setting. Strong enough for most work, though not quite so tough as urea resin glue.	Good for indoor furniture and cabinetwork. First choice for small jobs where tight clamping or good fit may be difficult.	Not sufficiently resistant to moisture for outdoor furniture or outdoor storage units. (Thoroughly clean up squeeze-out in areas to receive stain finish.)	Use at any temperature, but preferably above 60. Spread on both surfaces, clamp at once. Sets in 1½ hours.
RESORCINOL (WATERPROOF) GLUE	Comes as powder plus liquid, must be mixed each time used. Dark-colored, very strong, completely waterproof.	This is the glue to use with exterior-type plywood for work to be exposed to extreme dampness.	Expense, trouble to mix, and dark color make it unsuited to jobs where waterproof glue is not required. Needs good fit, tight clamping.	Use within 8 hours after mixing. Work at temperature above 70. Apply thin coat to both surfaces, allow 16 hours drying time.

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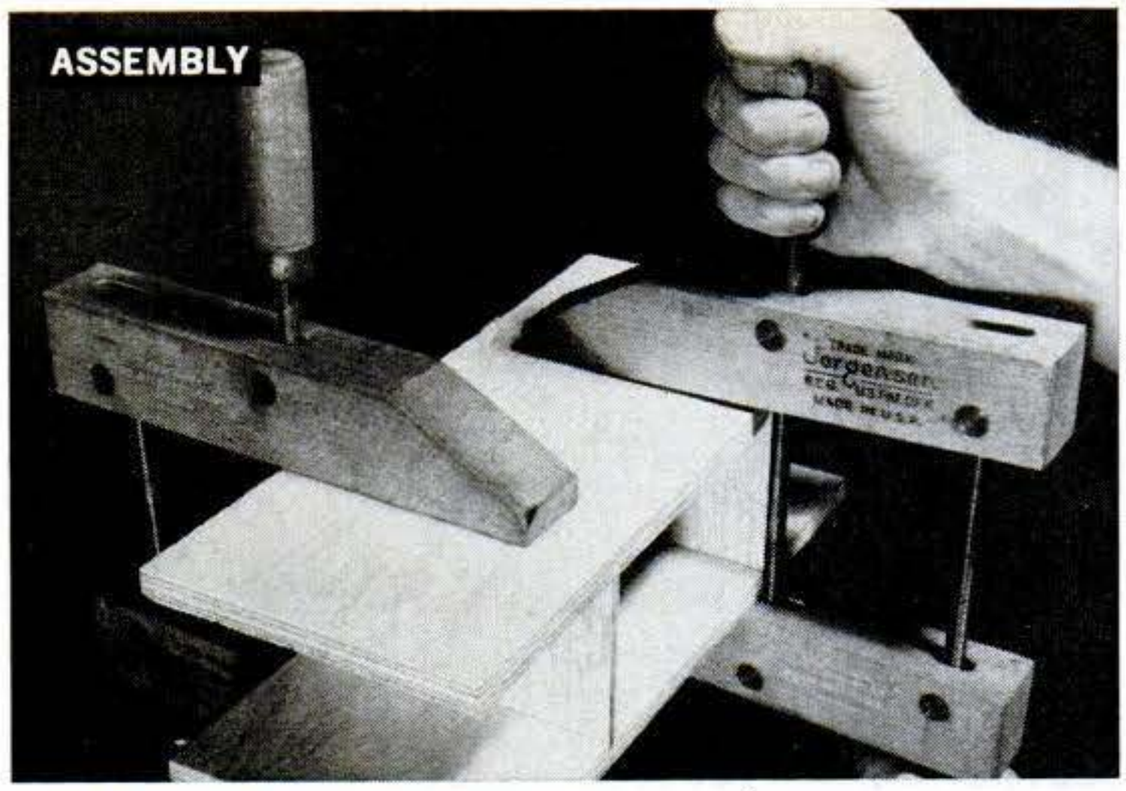

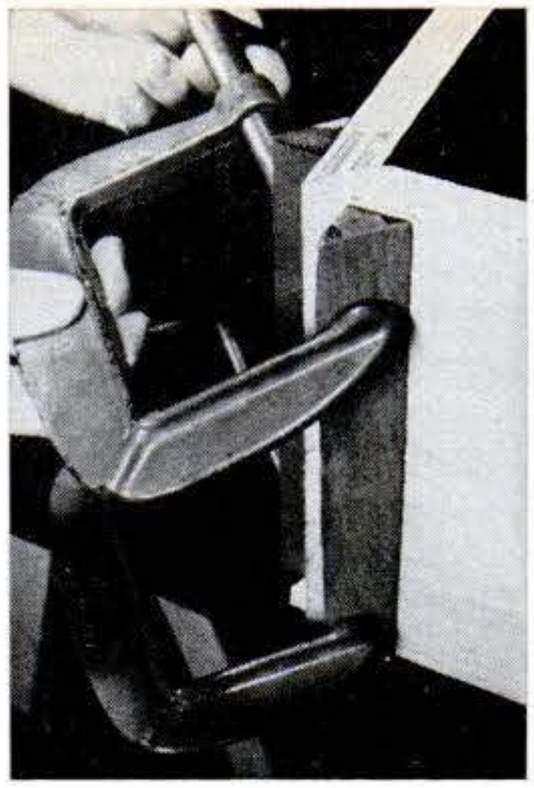

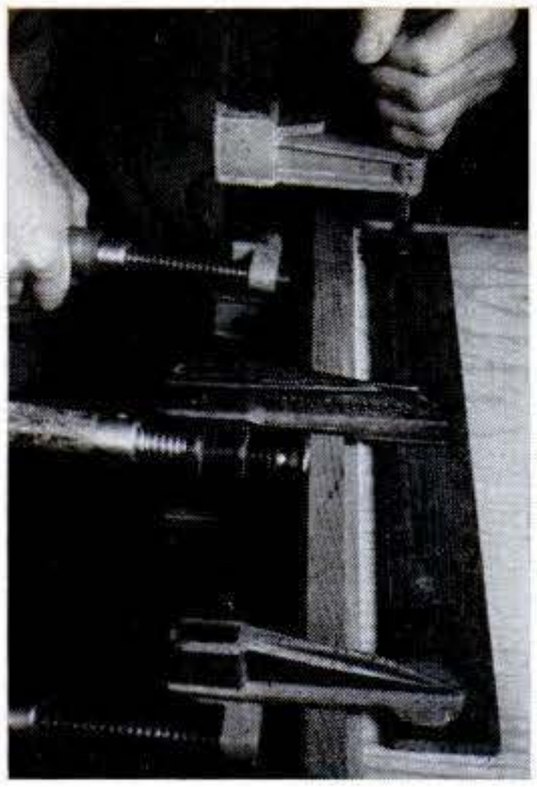

Don't put it all together at once: Break large, complicated projects into subassemblies that can be snugged with hand screws (above) or C-clamps (second photo). Adjust screws so full jaw lengths contact plywood. Mitered corners present a problem, but if you glue triangular blocks to each side (with paper strip in joint to permit easy removal), you can apply C-clamps as shown. Edge clamps (three types shown in third photo) hold wood (or laminate) strip while glue sets.

use, or (for indoor projects) a powdered putty you mix with water before use. Plaster spackling also works well. After the filler has dried, sand the edges well before applying paint.

If you're planning to cover the top of the project with plastic laminate, apply a narrow strip of the same laminate to the edges before you add the top piece.

What's the best finish for your plywood project? If it'll be outdoors, your best choice is stain. For textured plywood siding, you may want to use an exterior semi-transparent (also called penetrat-

[Continued on page 182]

Single-sheet plywood project contest rules

Popular Science, in association with the American Plywood Association, is looking for fresh, clever, well-designed projects that take full advantage of the practicality and economy of structural plywood. Whether you've already built a project that qualifies under the rules below, or wish to design and build one for us now, your ingenuity may be rewarded with a cash prize and publication in a future issue of *Popular Science.*

● **PRIZES:** A $1000 check will be mailed to the First Prize winner in each of two categories (Indoor and Outdoor). Five Honorable Mentions in both of these categories will qualify for a package of how-to books.

● **HOW TO QUALIFY:** Your project must be constructed from a single 4-by-8-ft. sheet of APA-grade-stamped plywood appropriate for the intended use, of proper thickness for structural strength; exterior grade for outdoor projects, interior for indoor (except for wet-area use). Projects must be carefully designed for efficient layout on a single plywood sheet; parts should be scaled, arranged, and nested to minimize waste. Your total expenditure for non-plywood materials should not exceed $75. Any project—functional or decorative—will qualify if it represents an efficient use of a single sheet and can be constructed with home-workshop tools.

● **HOW TO ENTER:** Fill out our entry coupon (or list all information the coupon calls for on a separate sheet of paper—including a rough sketch of the APA grade stamp on the back face of the plywood panel you chose). Mail this with at least one clear photograph and a dimensioned sketch of how the project parts were laid out on a single 4-by-8 sheet of plywood. We also need a list of all materials used: grade and thickness of plywood, plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down for us any special construction tips you'd like to pass along. Unless your entry photo is a color transparency, the negative must be available in case your entry print isn't publishable. If no usable negative exists, *Popular Science* and APA reserve the right to arrange photography. Entries must be delivered to the Tacoma Post Office Box by April 1, 1977, and become the property of APA and/or *Popular Science.* Print OUTDOOR or INDOOR in the lower-left corner of your envelope (only one entry per envelope, please). No entries can be acknowledged, and none will be returned unless accompanied by a written request and a self-addressed envelope with sufficient postage.

● **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of a single sheet of plywood for either an *indoor* project for the home or an *outdoor* project for the patio or yard (or for a recreational activity). PS will publish dimensioned plans of those prize-winning projects we feel our readers might want to duplicate. Plans for all 12 prize-winning projects will be available from APA after Sept. 1, 1977.

All 12 winners will be notified by May 1, and will receive their prizes by August 1. The winning entries will be announced in our August 1977 issue.

ENTRY COUPON (Clip and attach to your plans sketch)

Mail entry to:
POPULAR SCIENCE CONTEST
Box 2277, Tacoma, Wash. 98401

To qualify, entry must reach Tacoma address by April 1, 1977

YOUR NAME (print or type) _____

STREET ADDRESS _____

CITY _____ STATE _____ ZIP _____

Copy the plywood-grade stamp here

Description of project _____

Check one: ☐ INDOOR ☐ OUTDOOR

What thickness plywood? ☐ 3/8" ☐ 1/2" ☐ 5/8" ☐ 3/4"
If other, check here ☐ and specify _____

My signature certifies that this project is of my own design.

Sign here _____

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It's a lot easier than you think to help make your car last. For instance, make sure it's kept well tuned. Have maintenance check-ups performed when your owner's manual tells you to.

And be very careful about the motor oil and filters you use. Because they both protect your car's engine.

So make sure you use quality motor oil and filters.

Like Quaker State.

People have been using and trusting Quaker State Motor Oil for over 60 years. And for very good reasons.

It's formulated and blended by lubrication specialists, dedicated to producing quality automotive oils for your car. And before it leaves our refineries, it has to pass Quaker State's strict quality control standards.

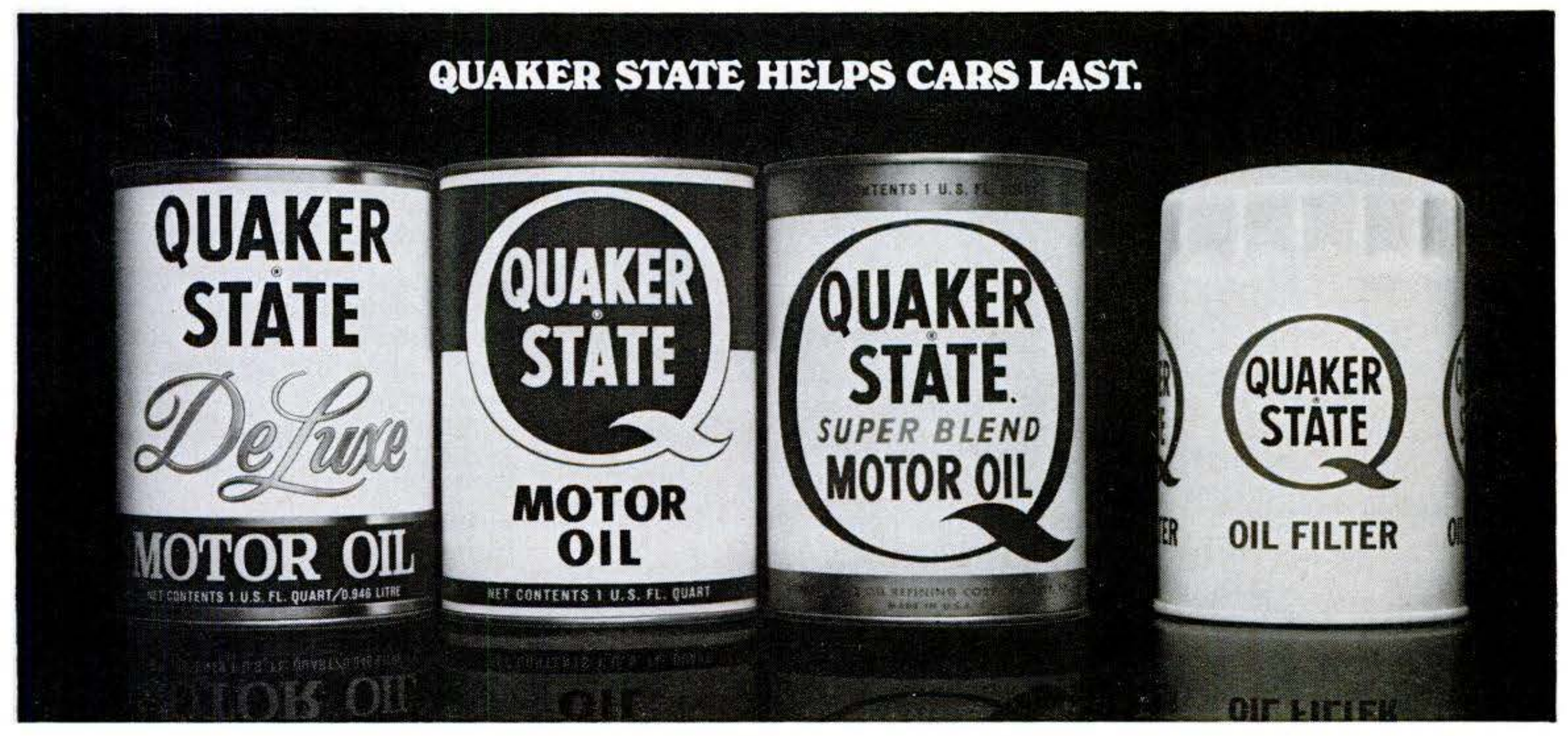
So by the time Quaker State reaches your car, you know it's going to do a great job.

Use it regularly and you'll help avoid expensive engine repairs.

And help keep your car from growing old before its time.

The fact is, more people buy Quaker State than any other motor oil in America. So look for Quaker State Motor Oil and Filters wherever they care about cars.

Because we'd like you to keep your car longer, too.



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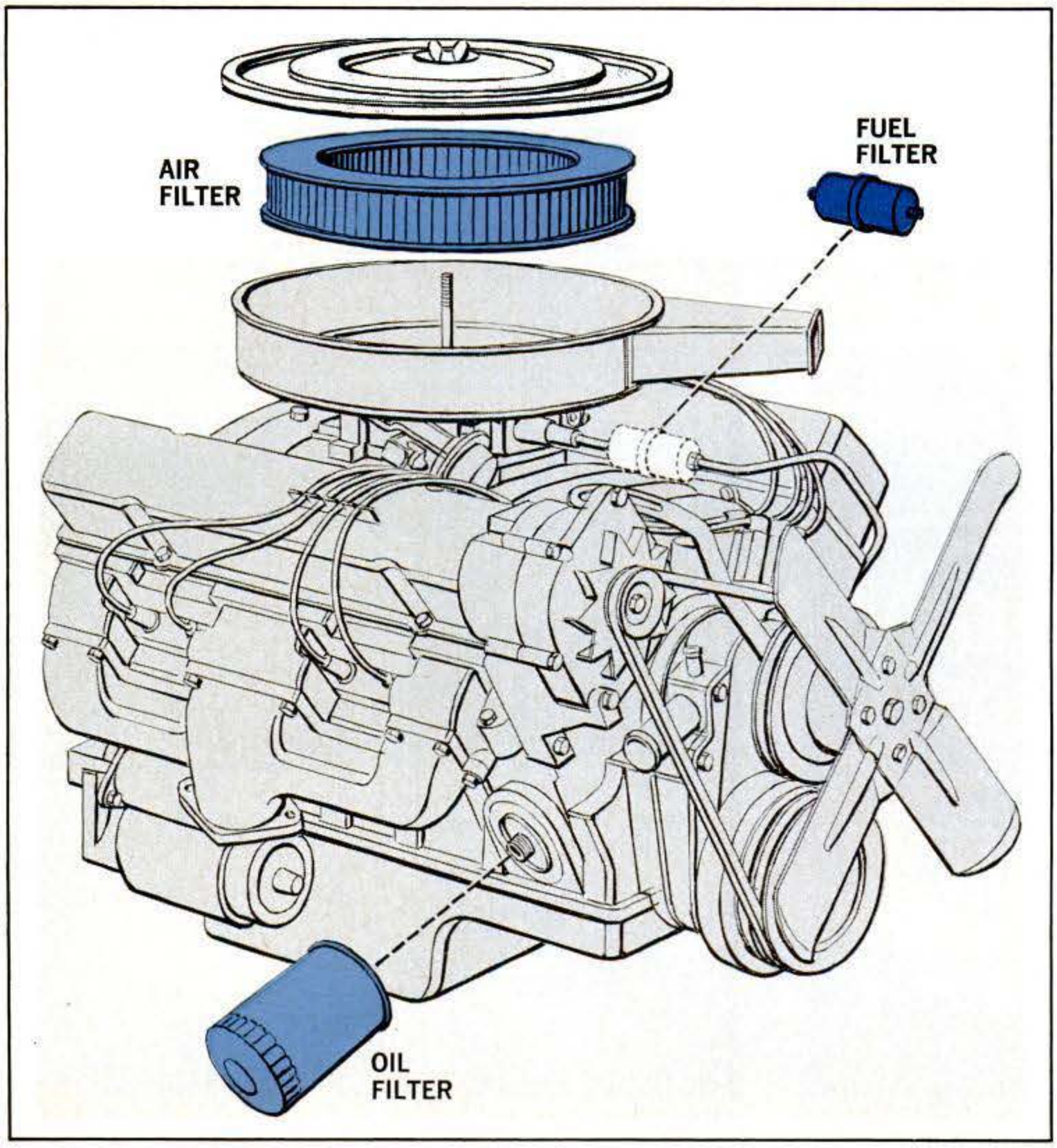
Car filters
–what to know, how to change them

By WALTER O. KOEHLER

Poor gas mileage, excessive carbon-monoxide emissions, rapid engine wear, and fuel starvation are a few of the troubles you can expect unless you service the filters in your car at regular intervals. Fortunately, this is a job you can do yourself without difficulty. Except for an inexpensive oil-filter wrench, no other special tools are required.

Efficient filtering systems are largely responsible for the durability of modern engines. All engines are protected by air cleaners, oil filters, and some form of fuel filter. Some have replaceable filters for the oil-breather cap. And cars built since the early 1970's have an evaporative-control system, designed to prevent the escape of gasoline vapor from the fuel tank and carburetor bowl; when the engine is shut off, these vapors flow through a line to a charcoal canister, where they are stored until the engine is started. There is a replaceable filter at this canister inlet, too.



What happens when filters are neglected? With an air cleaner, the element becomes clogged with dirt and restricts the flow of air to the carburetor. The engine is forced to operate on a rich mixture, which increases fuel consumption as well as emissions of carbon monoxide. When the oil filter is loaded with gook, a bypass valve opens and unfiltered oil flows through the engine, carrying tiny particles of metal and sludge-producing contaminants to internal engine parts. A fuel filter loaded with dirt restricts the flow of gasoline and may cause the engine to starve for fuel, especially at high speed. The solution to all these potential problems is quick and easy—change the filter.

The oil filter—two types

Your car's oil filter requires the most frequent service of all. It should be changed at least with every other oil change, though some experts recommend doing it at *every* change. When oil is drained, a quart of dirty oil remains in the filter. If the filter is not replaced, this dirty oil will quickly contaminate the fresh oil.

Two basic types of oil filter are in use today: the extended-area type and the depth type. Most new cars are equipped with the extended-area filters, which use specially

Continued

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You can't buy another Chain Saw with all these features at any price!

Auto-Sharp. Just press a button and sharpen your own chain automatically!

Chain Brake/Hand Guard Worth $16.95.* This vital safety feature stops a moving chain in milli-seconds to reduce hazard from kick-back. Not a tip, doesn't interfere with cutting.

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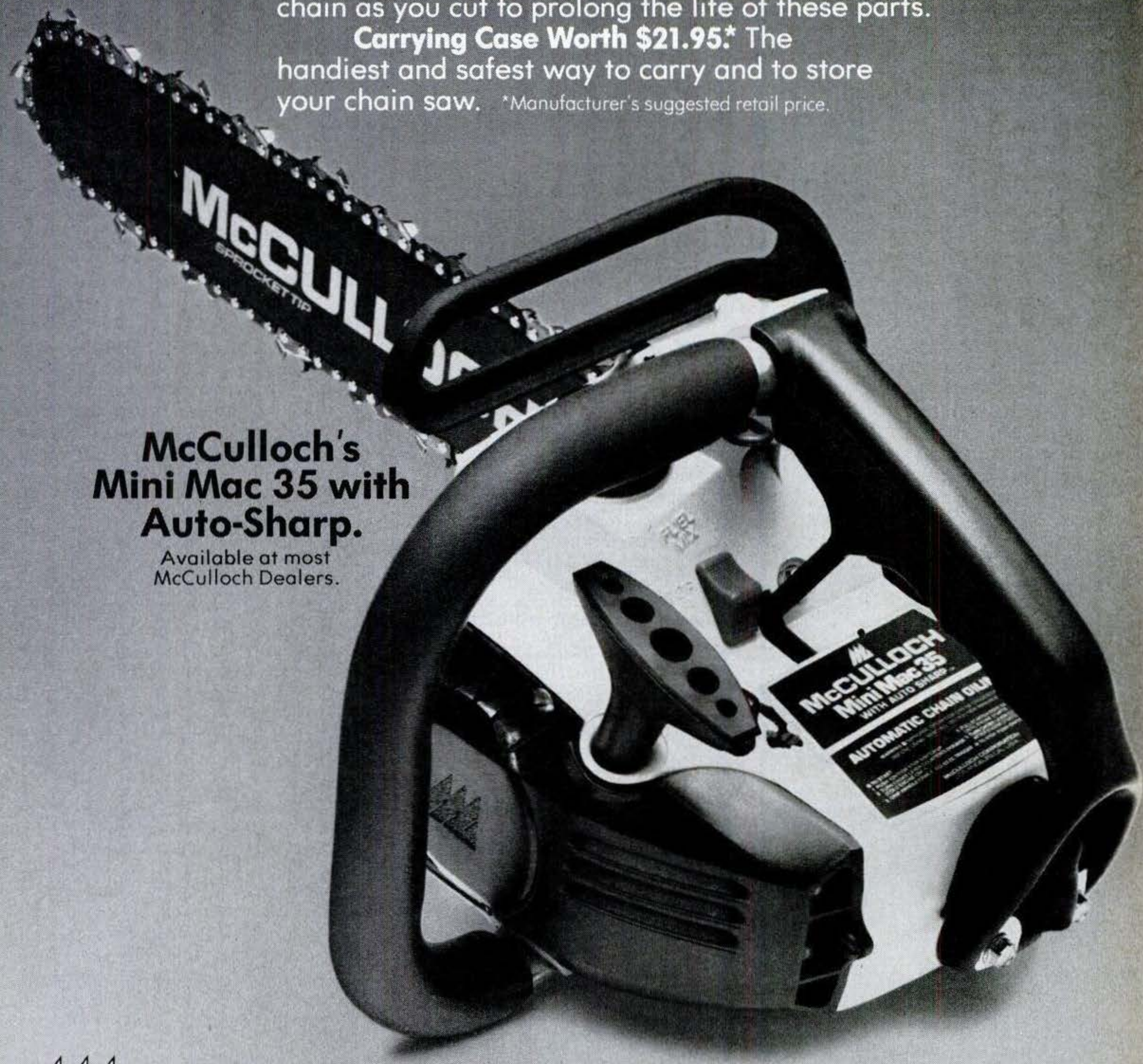

McCulloch's Mini Mac 35 with Auto-Sharp.

Available at most McCulloch Dealers.

McCULLOCH KEEPS AMERICA BUZZIN'

McCulloch Corporation, Los Angeles, California 90009

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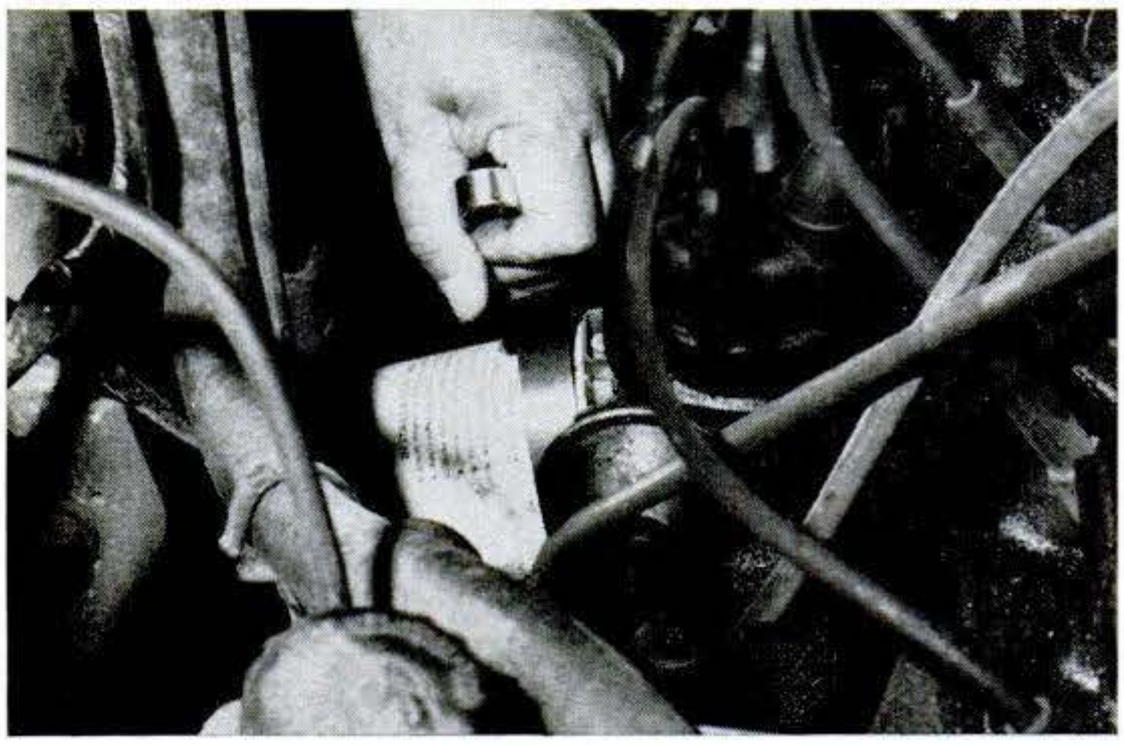

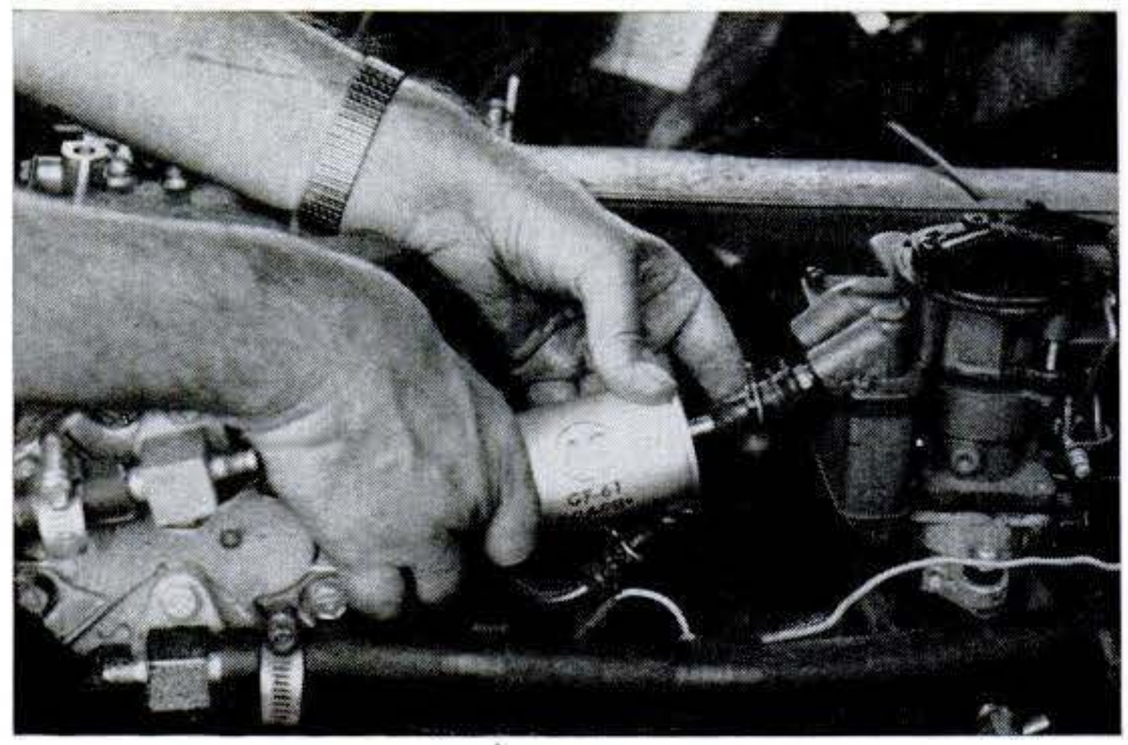

Oil-filter wrench (right) is placed over filter housing and is pushed or pulled for removal. New filter is hand-tightened in place.

In-line fuel filter fits between the pump and carburetor. Pliers are used to remove spring clips. Arrows on filter show direction.

treated paper that is pleated to increase its effective area. The depth-type filter is usually a two-stage design, with filtering material of cotton and excelsior or sisal. (Among the top makers of the extended-area type are AC, Fram, and Purolator; Lee, Motorcraft and STP make depth-type filters.)

In a technical booklet prepared for fleet operators, AC reports the results of a comparative test of extended-area and depth-type filters that (surprise!) claims vast superiority for the former. Indeed, says AC, the two-part element tested "so poor in particle retention that it couldn't be plotted on the same curve." When we checked this with makers of depth-type filters, they (another surprise!) discounted the test procedures. Generally, you're safest replacing the filter you remove with one of the same type.

The newest oil filter on the market is the Filter Plus ($5.95) made by Monroe Auto Equipment Co., better known for shock absorbers. In addition to its pleated-paper filtering element, the unit contains an additive disk inside the shell at the top. As oil flows through the filter, Monroe claims, this disk dissolves, releasing viscosity improvers, anti-oxidants, and anti-wear agents to replace ones that were originally blended into the motor oil, but that are depleted; the purpose is to extend the intervals between oil changes. [Any evaluation of types of filters is beyond the scope of this article. PS Detroit editor Jim Dunne is preparing a full report on oil filtering for a future issue.—*Ed.*]

How to change an oil filter

The first step is to buy a reputable brand and be sure it is the correct model for your car. Warm up the engine to normal operating temperature, then shut it off and drain the oil from the crankcase. The oil must be warm to ensure that all contaminants are removed. After draining the oil, replace the drain plug in the oil pan.

To remove the old filter, you will need a filter wrench, which is basically a steel band attached to a handle. Auto-supply stores sell them for about a dollar. The wrench handle must be oriented so that the band tightens around the filter as it's turned. (A small arrow may be inscribed on the tool to indicate the proper turning direction.)

Filters on some cars can be reached from under the hood, while others are accessible only from under the car. Slip the band around the filter body, push or pull the handle, and loosen the filter until it can be removed by hand.

Remove the old gasket from the filter mounting plate—if it does not come off with the old filter. Clean off the gasket-sealing surface on the mounting plate with a dry cloth, and apply a light coating of clean oil to the rubber gasket of the new filter. Place the filter on the threaded stud and turn by hand until the gasket makes contact. Then *hand-tighten* the oil filter according to instructions on the label or carton. The filter usually requires a two-thirds or a full turn for proper tightness. Do not overtighten or it will be difficult to remove it later. After installing the filter, fill the crankcase with the correct amount of fresh oil. Start the engine and check for leaks around the filter area. Recheck tightness if leaks occur. If it's sufficiently tight, re-

Continued

Inside of air-filter cover should be thoroughly wiped with damp cloth; do this well away from open carburetor top.

Simply drop a new, dry air filter into the housing above carburetor. Replace the top and tighten wing nut.

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AIR FORCE—A GREAT WAY OF LIFE

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move the filter and reset the rubber gasket. Replace the filter and test again.

The fuel filter

In storage and transportation, gasoline may pick up rust, dirt, and other impurities. If you're in the habit of waiting until the gas-gauge needle nudges the EMPTY mark before you refill the tank, the fuel pump is likely to pick up sediment from the bottom of the tank. Fuel filters trap impurities that might clog carburetor jets or cause abrasive wear in the engine.

Charcoal canister is removed by loosening a strap. The new filter is squeezed in under a retainer bar.

You'll find the fuel filter in one of two places—in the carburetor's fuel inlet or in the line between the fuel pump and carburetor. To service the integral type (in the carburetor's fuel inlet), disconnect the fuel line at the carburetor and remove the filter. If you own a late-model car, the filter is probably a disposable pleated-paper unit. Don't try to clean it. Replace it with a new one. Connect and tighten the fuel line. Start the engine and check for leaks at the carburetor inlet. If you have an older car, you may find a small sintered-metal filter in the fuel inlet. This type can be cleaned in kerosene or solvent and used again.

To change an in-line filter, first loosen the clamps and slide them along the rubber hoses until they clear the inlet and outlet pipes of the filter. Then pull the filter out of both hoses and discard it. Remove the old clamps and throw them away. Place the new clamps supplied with the filter on the hoses and slide them away from the ends of the hoses to permit insertion of the filter pipes. The new filter has arrows that point toward the carburetor when the filter is installed correctly. Install the filter in both connector hoses and slide the clamps into position. Start the engine and check for leaks at the filter inlet and outlet.

The air cleaner

For every gallon of gasoline your engine burns, it consumes about 15 times the weight of that fuel in air. Much of that air contains dust, particles of industrial waste, and other impurities. Mixed with oil, these foreign materials would form an abrasive compound that would grind away the metal of internal

Continued

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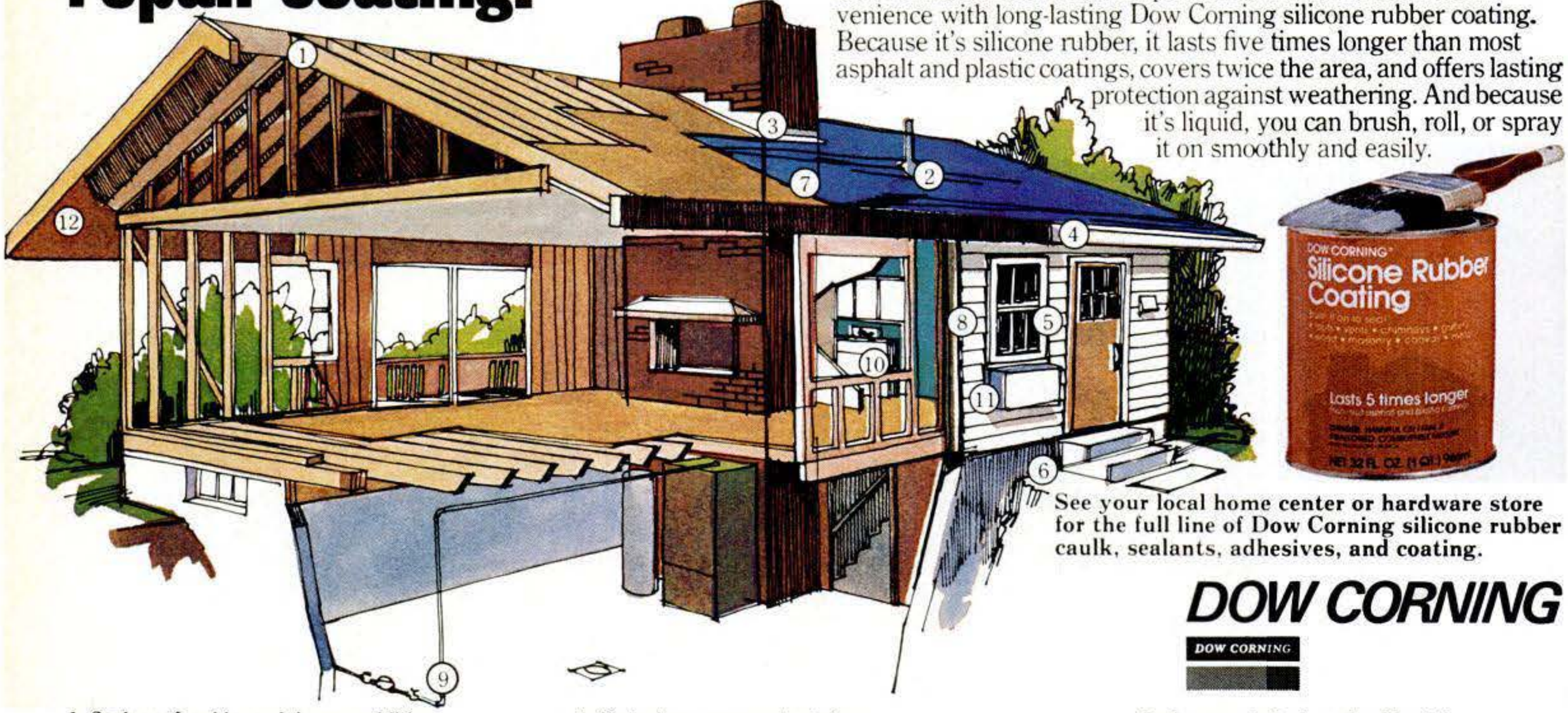

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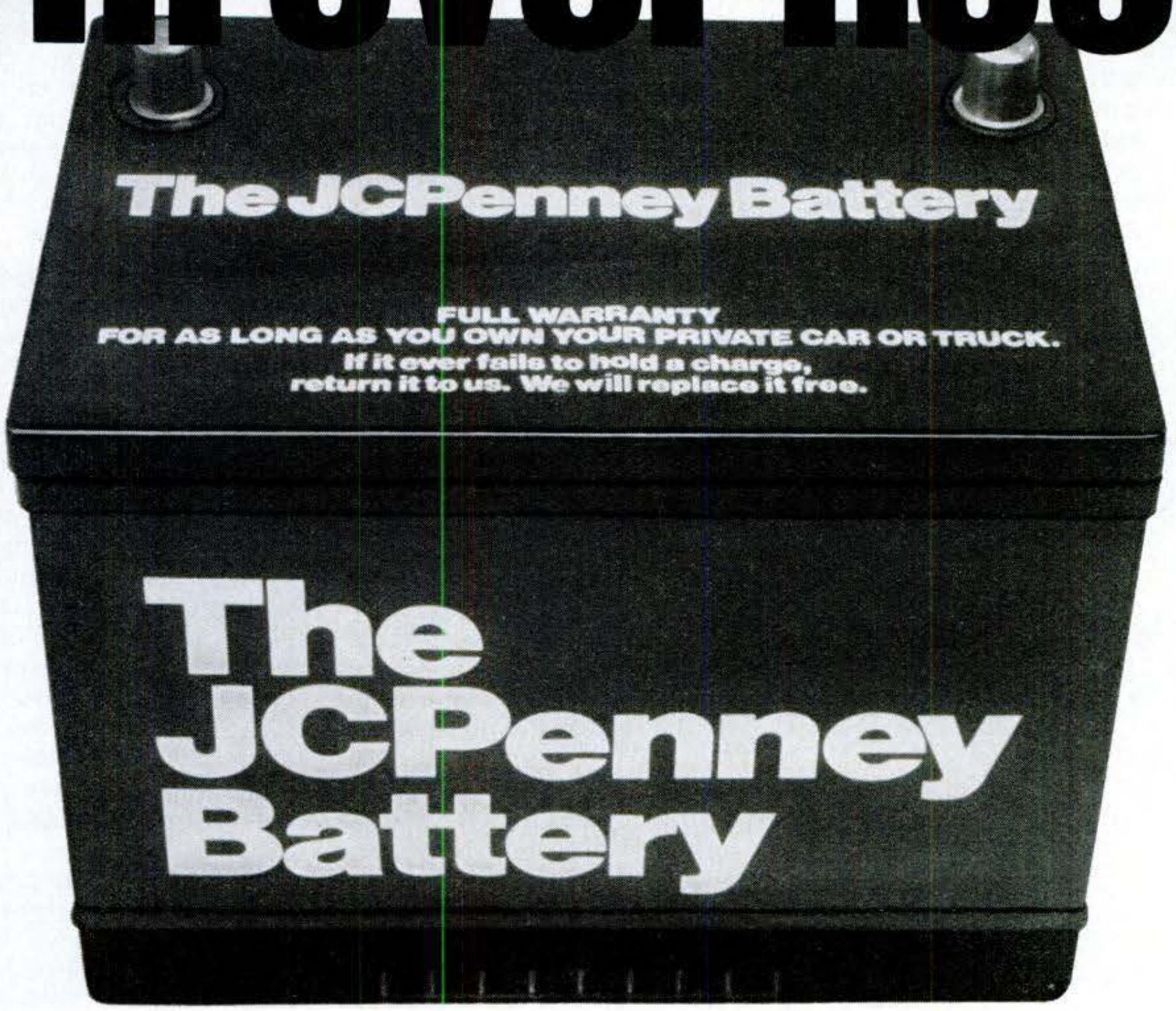

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engine parts. An air cleaner prevents this.

The dry-type air cleaner with throwaway element is used on nearly all new cars. The filtering material is pleated paper, sandwiched between two plastic rings, and located inside the air-cleaner assembly above the carburetor. To replace, unscrew the wing nut on the air cleaner, remove the top, and lift out the filter. If it isn't too dirty (check it at every oil change), the element can be cleaned by tapping it lightly on the pavement or by air-spraying from the inner circumference. The element should be replaced at the mileage specified by the car maker, or more often if the car is operated in dusty areas. You should also wipe out the inside of the air cleaner housing with a damp cloth. It's best to remove the housing before doing so, in order to keep dirt from being brushed into the carburetor. If your car has a thermostatically controlled air intake, there is a hose running from the air-cleaner snorkel down into the engine compartment; disconnect it before you remove the air cleaner. (The hose is lined with metal foil and will break if it's bent too far.) Replace the old filter element with a new one that's appropriate for the model of your car.

General Motors has carried the throwaway idea one step further. The Chevrolet Vega, Pontiac Astre, and other vehicles powered by the four-cylinder aluminum engine have an air cleaner with welded housings. At 50,000 miles, the entire assembly should be thrown away and replaced.

Oil-bath type

Until a few years ago, an oil-bath air cleaner was used in many cars. Air enters the cleaner through the space between its inner and outer walls and travels downward toward the oil-filled reservoir in the lower part of the housing. Momentum of the heavier particles carries them into the oil in the reservoir. At the same time, the main stream of air churns up the oil on the surface of the reservoir, creating a mist of tiny oil droplets. Dirt in the air is trapped by these small drops and carried upward into a metal gauze filtering element. Clean air emerges from the upper end of the element, makes another U turn, and flows downward through the center of the housing and finally into the carburetor.

To service the oil-bath air cleaner, you must remove the entire assembly. Pour the old oil out of the reservoir and clean the inside of the assembly with kerosene. Wash the filtering element in kerosene and let it drip dry. Fill the oil reservoir to the level line with clean oil of the grade recommended by the car maker. Wet the filter element with the same grade of oil, reassemble the filter, and install it back on the housing.

If you own an older GM car, you probably have an air cleaner with a filtering element of plastic foam. To service this unit, unscrew the wing nut, remove the top of the filter, and lift out the element. Wipe the inside of the filter housing with a damp cloth, and wash the element in warm water and mild household detergent. Rinse, squeeze out the excess water, and hang up to dry. Reinstall the element, then replace the filter cover and the wing nut. If the element starts to break up, replace it.

One air cleaner that is virtually obsolete is the wetted-mesh type. It has the same type of metal-gauze filtering element as the oil-bath cleaner, but without the oil reservoir. The gauze element should be washed in kerosene.

Other filter checks

- *Oil breather cap:* If your engine has a conventional breather cap, it should be washed in kerosene when the oil and oil filter are changed. Throwaway breather elements should be replaced at the same interval.
- *Charcoal-canister filter*: Change the filter at the mileage recommended by the car maker. Consult your owner's manual for the location of the canister. Disconnect the hoses from the top of the canister and unscrew the retaining strap. Dismount the canister and remove the filter element by squeezing it out from under the retainer bar. Squeeze a new filter element under the retainer bar and reinstall the canister.
- *Transmission filter:* For average driving, the transmission filter will last the life of your car. But for heavy-duty driving (taxis, fleet cars, etc.) it's recommended that this filter be changed every 30,000 miles. [For more details on transmission filters, see "How to service automatic transmissions," which appeared in this series in September, '76.]

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A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes—take your jacket off, and you're lost!

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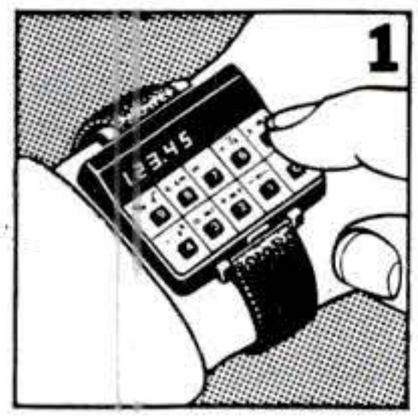
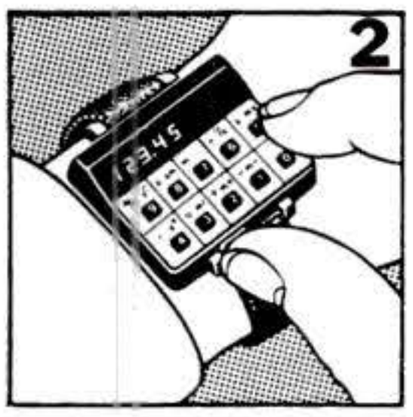
This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable $19.95. And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

How to make 10 keys do the work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions $\sqrt{x}$, $1/x$, x^2; plus a full *5-function memory*.

All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.





1. The switch in its normal, central position. With the switch centered, numbers—which make up the vast majority of key-strokes—are tapped in the normal way.

2. Hold the switch to the left to use the functions to the left above the keys...

3. and hold it to the right to use the functions to the right above the keys.

The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

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The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components *free*: we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Actual Size

Contents
Case and display window.
Strap.
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Special direct-drive chip (no interface chip needed).
Display.
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The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10 day money-back offer.

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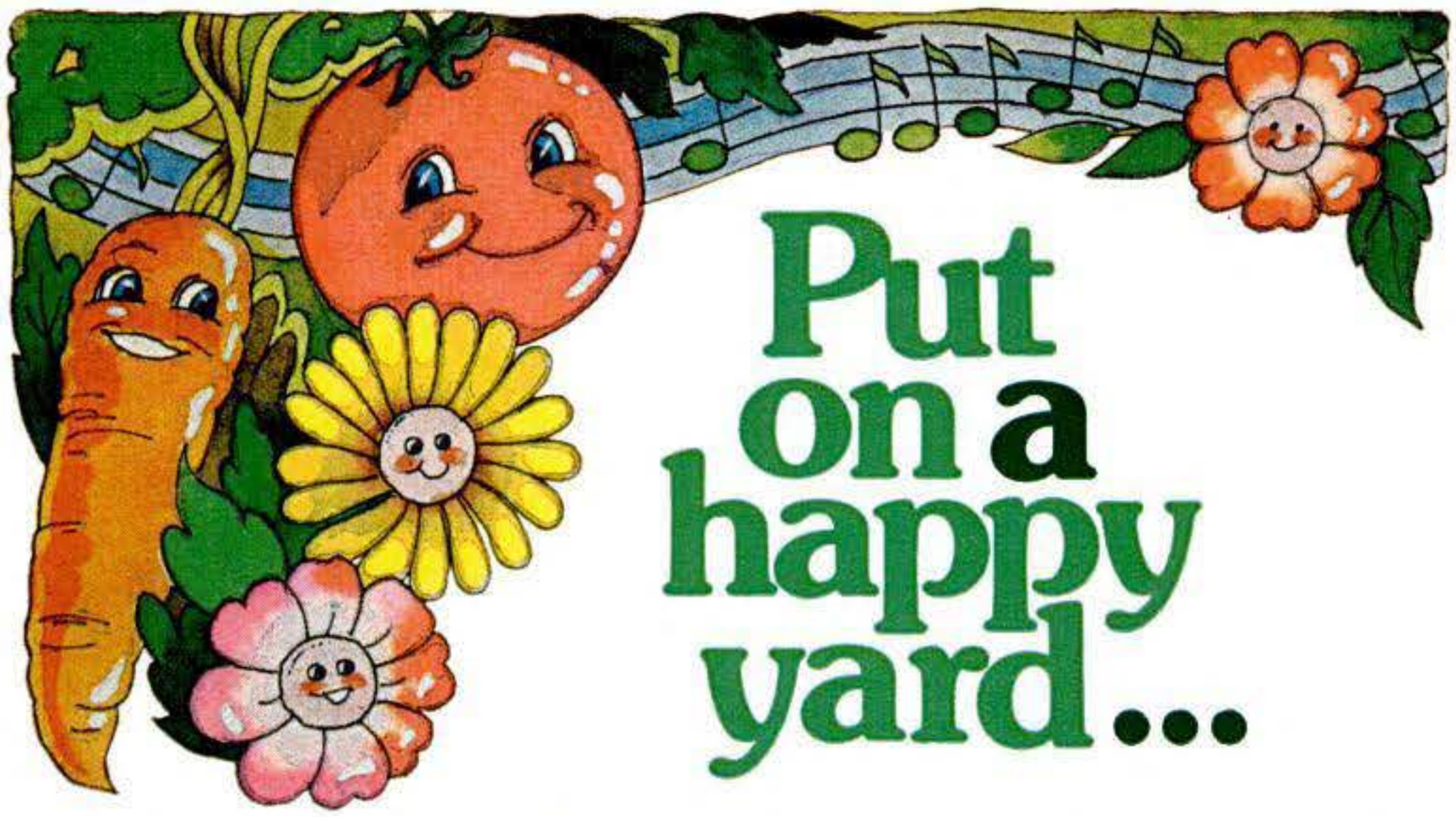

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New, tough **electrically conductive fabric**

If the little lumps and wires in your electric blanket keep you tossing and turning all night, like the princess who had a pea under her mattress, take heart. You may soon be able to snuggle under an electric blanket that's as smooth as even the royalest princess could desire. A new fabric, called 'Lectrolite, could make such a comfortable blanket possible.

The fabric, developed by the Herculite Corp. (1107 Broadway, New York, N.Y. 10010), is made of high-strength nylon filaments sandwiched between vinyl sheets to form an electrically conductive material—without wires or metallic threads. The fabric looks like shower-curtain plastic with a fine screen-wire texture embossed in it.

'Lectrolite has many desirable properties: It is flame-resistant and light; one square yard weighs just 10 ounces. It is strong, withstanding tearing forces up to 85 pounds. It wipes clean with soap and water. It is resistant to abrasion, fluids, mildew, rot, and most chemicals, so keeping the blanket clean should not be a major ordeal.

'Lectrolite was originally developed for the health-care industry, where it is used for sheeting and mattress covers in operating rooms and intensive-care units to minimize the danger of explosions from flammable gases, and to eliminate the possibility of electrical interference with sensitive life-support systems. The conductive fabric simply draws off stray currents.

In comparison tests with other commercially available conductive fabrics, 'Lectrolite proved to be more than twice as tear-resistant as the strongest of them; it also proved flame-resistant while the others burned readily.

"We believe there are potential uses for 'Lectrolite in a broad range of industries from mining to textiles to electronics and communications," says Sy Hyman, chairman of Herculite. Eventually, the fabric will find its way into consumer products. You could use it to keep equipment warm or to prevent frozen pipes and plumbing. And perhaps in a year or so, you can donate that lumpy electric blanket to a lady-in-waiting and buy yourself a smoothie to replace it.—*V. Elaine Smay.*

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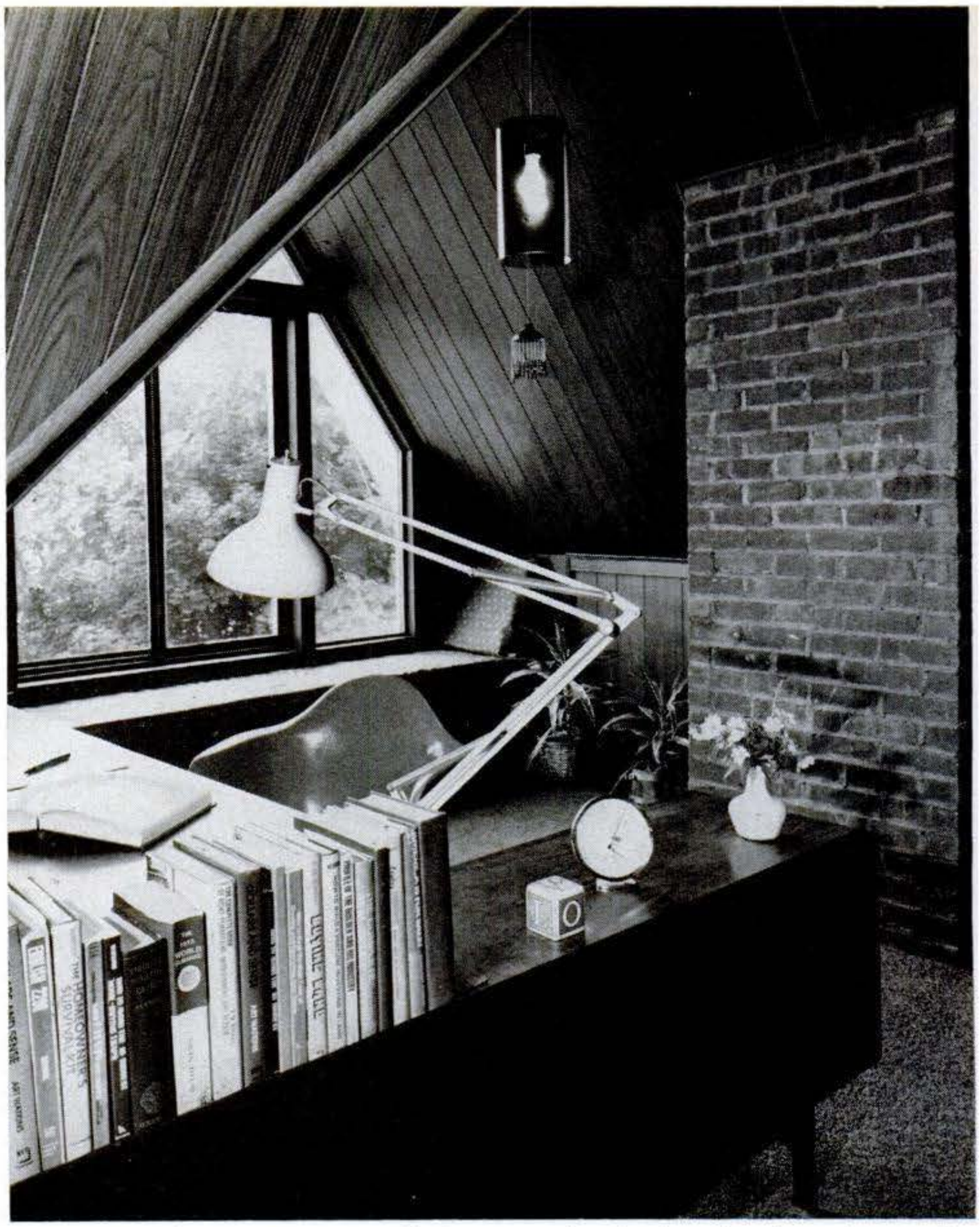
Add an energy-efficient **room at the top**

Novel ventilation and solar gain through big windows tame attic temperatures

By A. M. WATKINS



New attic office has large east-facing gable window that lets in plenty of light —and solar heat in winter. An exterior shade is drawn to block summer sun.

Putting a new room into an old attic has always been a challenge. The sloping roof makes it difficult to provide window space for adequate light and air. Even worse, space under the roof is notoriously cold in winter and hot in summer. And today that problem is compounded by the skyrocketing cost of heating and cooling.

I was determined to avoid these problems when I transformed my unfinished attic into a year-round office and study. Solution: plenty of insulation, an under-roof ventilation system, and double-pane windows placed for best solar gain. The result is a room that's pleasant and comfortable no matter how hot or cold the weather. And my energy bills are surprisingly low. If you're considering making a useful living space in your attic, perhaps some of the techniques I used will help you create a similarly satisfying room.

Designing the windows

The windows were my biggest challenge, and are likely to be yours. The space available for my new attic room was comparatively small, so I wanted large windows to make the room feel larger. The conventional wisdom today says to keep down the size of your windows to conserve heating and cooling energy. That's all right if you don't mind living in a cave, and are willing to give up solar gain during the winter. But with proper design you don't have to.

Double-pane glass, which I used for my windows, cuts heat loss by roughly 50 percent, compared with single-pane. It pays off in extra comfort, too. Even on cold windy winter days, no drafts or cold spots develop to make the room uncomfortable.

Studies by the National Bureau of Standards say that double-pane glass generally will pay for itself in heating-cost savings in a cold climate (2500 degree days or more), especially if you use high-cost oil or electric heat. Just how long the payback period will be depends on many variables, such as the size of the window area, the climate, and the cost of fuel. Double panes are particularly important for windows on the northeast to northwest side of a house, which are lashed by cold north winds in winter, and get little or no sun. If your building budget is stretched tight and you live in a moderately cold climate (2500 to 5000 degree days), you can economize by using single-pane glass for the southern exposure.

In a really cold climate (more than 7500 degree days), even triple-pane glass—especially for the north side of your house—can pay off in comfort and reduced energy use. On the other hand, for houses in the South with only modest heating requirements, stick with single-pane, since multiple glazing does little to lower air-conditioning costs [see "Energy-Saving Aluminum Windows," PS, Oct. '75].

Double-pane glass can get expensive, but you can save on this bill by using fixed-glass units. I used them for all but one window section, where I installed a sliding-glass unit for ventilation and a quick fire exit. Fixed-glass units can run 50 percent less in price than windows that open and shut; they're also easier to install.

You'll be able to save even more if your windows are designed to take stock-size glass panes. These are mass-produced and come in a wide range of sizes.

Location of the windows is crucial for purposes of aesthetics, good lighting, and energy conservation. The easiest place to put new win-

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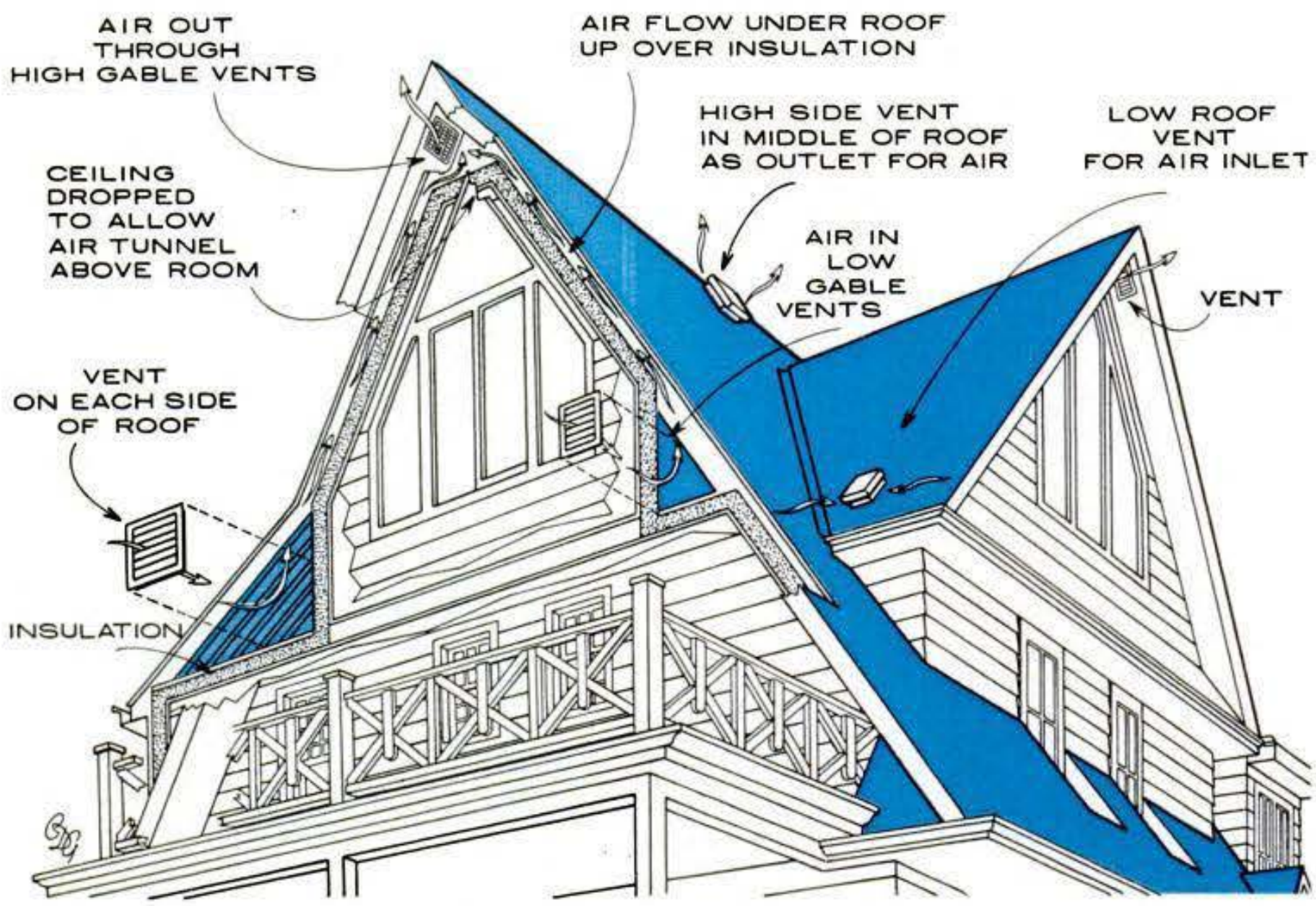

Open space between roof and insulation provides ventilation for summer cooling and prevents condensation in winter. Diagram shows system: Lower wall and roof vents draw in cool outside air, which rises as it warms. Warm air exits from vents near top of roof. Arrows on photo below show vents.

Attic remodeling doesn't alter house structurally. Before, each attic gable had small double-hung window (right).

dows in an attic room is, of course, in the gable ends of the house. But if gable windows won't provide enough light, and you also need more head room, you'll have to add a dormer—a major project that can get expensive. If your ceiling height is adequate, however, you could get the window area you need by installing skylights or skydomes [PS, Sept. '73].

If you can, locate the bulk of your glazing on the south side, where it will capture the most solar heat in winter. This can cut your fuel bills by 40 percent. Southern windows are also easiest to shade from the hot summer sun—merely build a brim-like roof overhang above them. Remember that in winter in the northern hemisphere, the sun rises in the southeast, arcs relatively low across the sky, and sets in the southwest. In summer, the sun rises in the northeast, arcs much higher across the sky, and sets in the northwest [PS, Feb. '75]. So an overhang can shield a southern window from the high summer sun, but admit the lower winter rays. To protect my east windows from the summer sun, I installed an exterior rolling shade that pulls from the inside. Shading on the outside keeps out twice as much heat as shading on the inside.

Windows on the southeast, east, and southwest are, in that order, next best for admitting solar heat in winter. North-facing windows let in the most cold—and no free sunshine.

Insulation

On a sunny cold day, I find that enough morning sun pours through my eastern window to keep the room cozy most of the day. This free heat is retained by the double-pane glass in the windows and by the ceiling which is beefed up with eight inches of batt insulation. Actually many experts today would feel that eight-inch insulation is on the low side for a room like mine (with electric heat and air conditioning) and for my winter climate (5000 degree days). Twelve inches would probably pay off [see "Home Insulation," PS, Sept. '76]. Thick insulation also helps to keep down summer air-conditioning costs.

I heat my new room with two slender electric baseboard units, one under each window. This gives me independent control over the temperature of the room, and lets me turn off the heat when the room is unoccupied. To my surprise, I've discovered that only one unit is needed. If I were to do the installation again, I'd install enough electrical capacity for two units (the number called for in standard heating calculations) but put in only one; then I'd add a second only if experience showed that it was needed.

Ventilation

Attic space has to breathe, so a good air wash under the roof is important. In the winter, without such airflow, water vapor rising from below will condense when it hits the cooler air under the roof. That can

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MY FRIEND,

I'm getting old , and I don't have much longer to live. Unless I do this now, when I go the secret goes with me.

What I am about to give you is KNOWLEDGE...the knowledge that men have been searching for since time began.

I used to be an ordinary man. I spent the early part of my life stumbling in the dark, trying to find a way to make all the dreams I had as a young man come true. I wanted, like most young people, to be wealthy, admired, respected. I wanted love and happiness. I also had many questions about life and I wanted some answers. Yet, no matter how hard I tried, everything always seemed to be kept from me. As though it was all hidden in the very next room, a room whose door was impenetrable without the right key.

After years of being kept from those things that I wanted most in the world my spirit could have easily broken if I allowed myself to become consumed with failure and rejection. Little could I know then how lucky I was for this to have happened to me. For something grew inside me that would not let me rest until I found the answers that would bring me all the things I so desperately wanted.

This was the beginning of a search that would become an obsession. To find the knowledge that I so desperately longed for and knew must exist somewhere. The inspiration of the great men of the past took much of the torment away. The multimillionaires and recluse billionaires that seemed to have the world at their beck and call. The men that were able to control the very destinies of nations. How they held respect and admiration, how they were rich and powerful but not me, never me. What did all these great men have that I didn't? I knew there must be an answer and I dedicated my life to finding it; because I knew there could be no true life for me until I did.

I started to read, to do research into the past. I spoke with and studied of the richest, the most powerful, as well as the wisest men of my time. I read every possible piece of literature that I thought would hold a clue. I delved into the oldest recorded writings of the ancient civilizations. I studied and I learned. Trying almost insanely to put all the pieces of this great puzzle together. I kept asking myself, what did these men have? What did they have that I didn't and how could I get it?

I involved myself in all sorts of situations trying to put into practice what I had learned. I traveled with the hope that the answers might somehow lie beyond the horizon and though I didn't find them there, I know now that the proverb, "Seek and ye shall find," couldn't be more true. *For when the answers were finally revealed to me they came in a way that I could not directly attribute to any place I had been or any individual effort I had made to find them.* It was as though my mind had crossed into a new frontier, a frontier that I was certain relatively few men had ever gone into before. Suddenly I saw the whole world differently, what seemed confusing before I could easily understand. What was unobtainable before suddenly became easy to get. The things that people saw one way I saw differently as though I could detect more aspects of the same thing and thereby see it more clearly or as it truly was. I had an undefined power that gave me an advantage over everything I did. After a while I realized that I was very different from before. I was at last the way I wanted to be. I had learned what I wanted to learn and was at long last able to live the way I had dreamed and knew it was possible for a man to live.

The late J. Paul Getty standing in the courtyard of his home at Sutton Place, London. The knowledge, wisdom and experience of this great man is now yours to share, as he intended you to. But it's up to you to make the decision to accept it.

It is written, "Once in a thousand years a man lives a dream." For the last third of my life that is exactly what I have done. I have lived with more wealth and power than any man could ever want. I have done almost everything that I have set out to do. I doubt if there has been a man who has lived a more fulfilled life than I. But now I have only memories. This, in my opinion, next to life itself, was the greatest gift that a man could be given. But now I have come to realize that if I don't share this knowledge now I may never get another chance to do so. I now know that I am obligated to share it and in the end this was the way the fates had destined it to be.

I would like you to have my secret, but you'll have to realize that this ad will be read by many people, many whom I do not know but a few will be chosen to carry on for me after I am gone. I have written what I have learned and published it in a special limited edition book that contains only 344 pages. I have titled it "The Secret of the Ages." I want you to own a copy of this book that is specially bound in library-type binding, but I want you to pay for it. I want you to send me a check for twenty dollars that you may even postdate up to thirty days to eliminate any doubt as to its value and to give it a chance to prove its worth to you.

The reason that I am asking you to pay twenty dollars is that I want to make sure that you read it and I feel that if you paid twenty dollars for it, then it will be read.

With my book, I will also send you a book written by the man who was renowned as the richest man in the world, a man whom I've had great respect and admiration for, the late J. Paul Getty. His book is "The Golden Age." I have bought at great expense, the rights to publish this great book after Jean Paul's recent and sad departure from this world. I have also printed it in very limited quantities. The book is bound in special library-type binding that should allow it to last for generations to come.

I feel that it is essential you read, along with my book, the message that Jean Paul wanted you to learn...and acquire the truths that took the richest man in the world his entire lifetime to learn.

Therefore, I am making you the following offer: If you feel that after reading my book it is not worth many times more than the mere twenty dollars you've paid for it, then send it back to me and I will return your uncashed check immediately. Not only that, you can keep J. Paul Getty's book "The Golden Age," for your trouble. You can lose only if you do nothing.

If you want to own these two books, write on a blank piece of paper the words "Send me the books," along with your name and address. Mail it along with your check, that may be postdated up to thirty days, to me, Robert G.Collier, in c/o Collier Book Corporation, Dept.PS-3, 531 Wyckoff Ave., Ramsey, N.J. 07446

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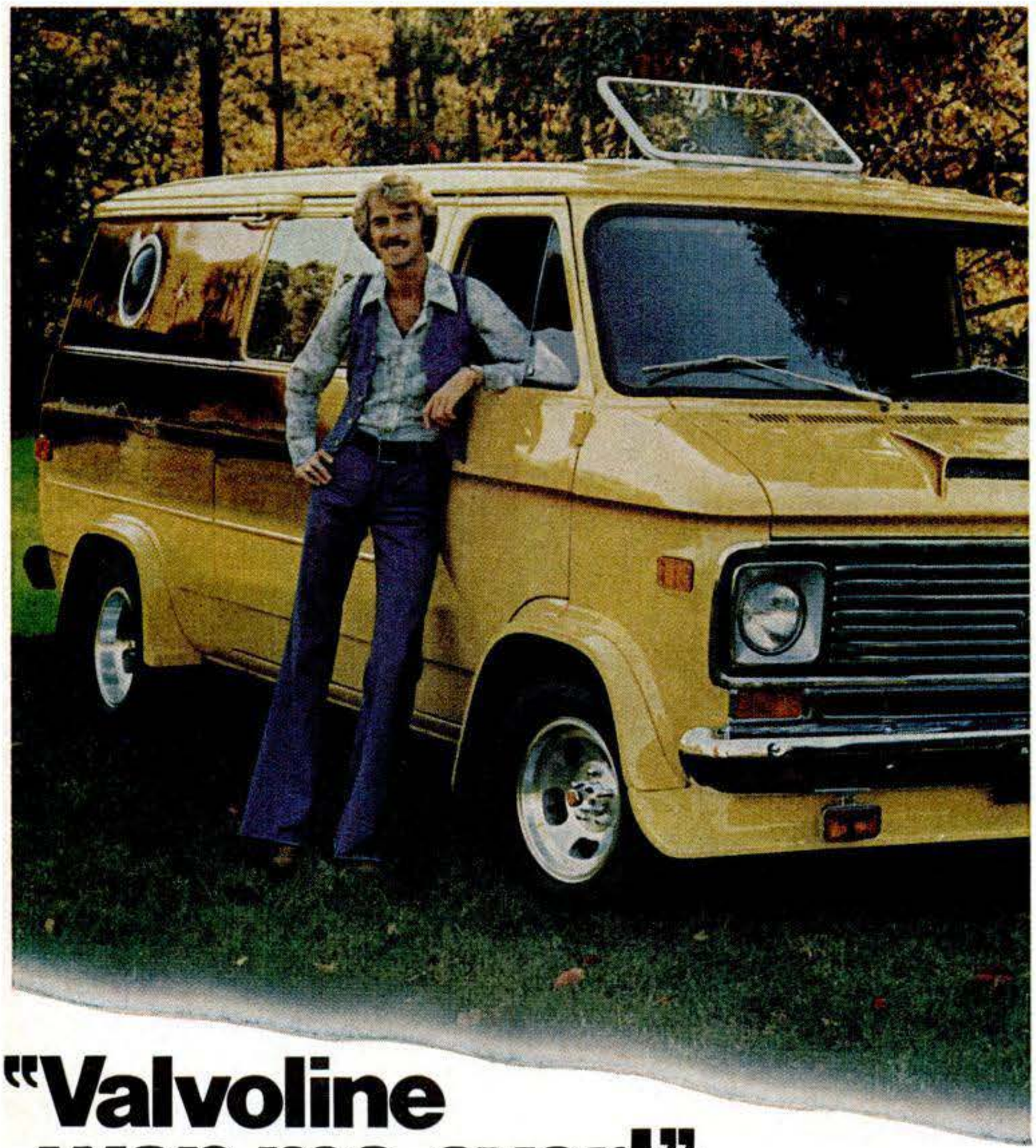

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Room at the top

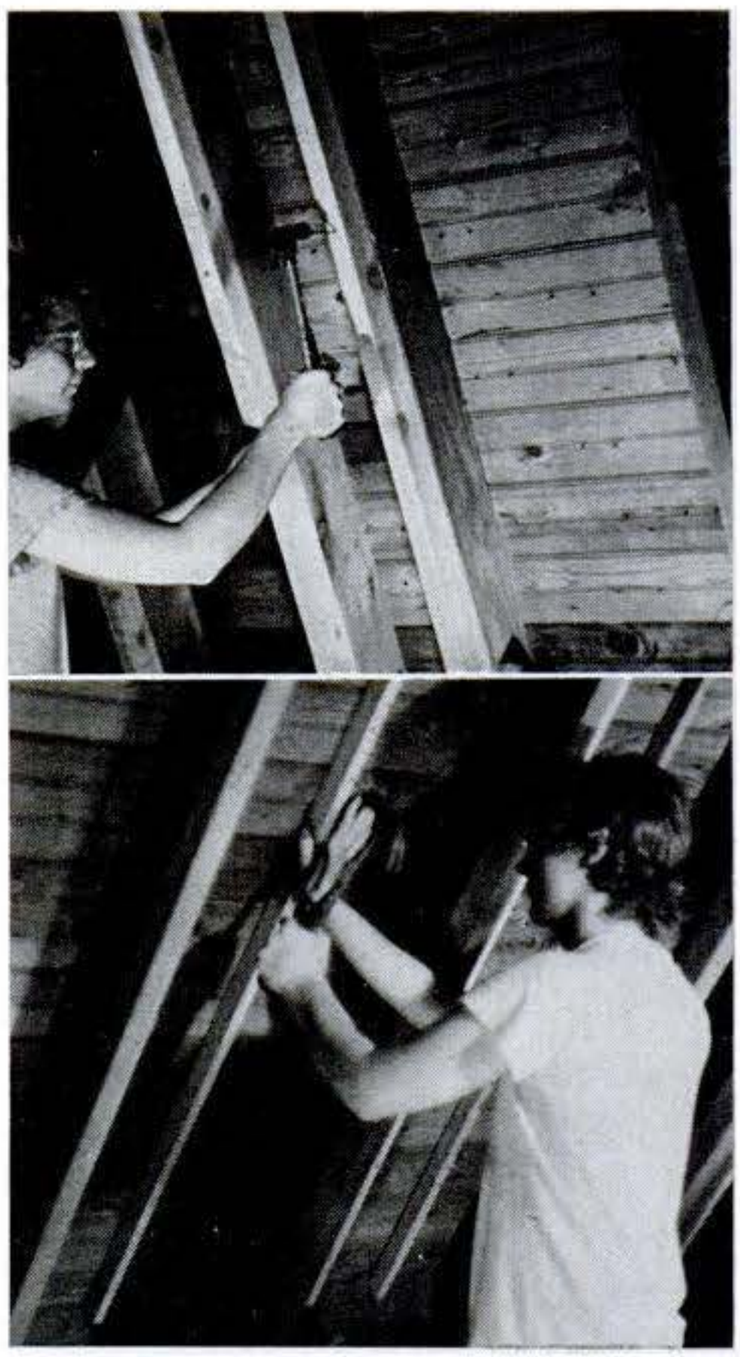
[*Continued*]

damage the roof and dampen and cripple your insulation. In summer an air wash is needed to prevent furnace-like heat from building up under the roof.

The Federal Housing Administration (FHA) calls for a minimum of one square foot of net air venting for every 150 square feet of attic floor area—half as much if your insulation is covered with a vapor barrier or if a combination of high and low vents is used.

Providing the necessary ventilation was a problem in my house because the 2-by-6 rafters (the size found in many houses) didn't have enough depth to allow for thick insulation plus the air space needed for venting. My solution was to nail on a 2-by-3 to widen each rafter. To insure an air space between the top of the insulation and the underside of the roof, I nailed 1-by-2-inch cleats to the underside of the roof between each pair of rafters.

To let outside air into this gap between insulation and roof, I installed intake vents near the eaves and outlet vents near the ridge. A natural air wash results, since warm air rises. The air flows up the outside of the insulation and out the top. PS



Air space for ventilation was provided by nailing 1-by-2 strips between rafters. This holds insulation away from roof. Rafters were extended by adding 2-by-3's, giving actual rafter depth of 8⅜ in.

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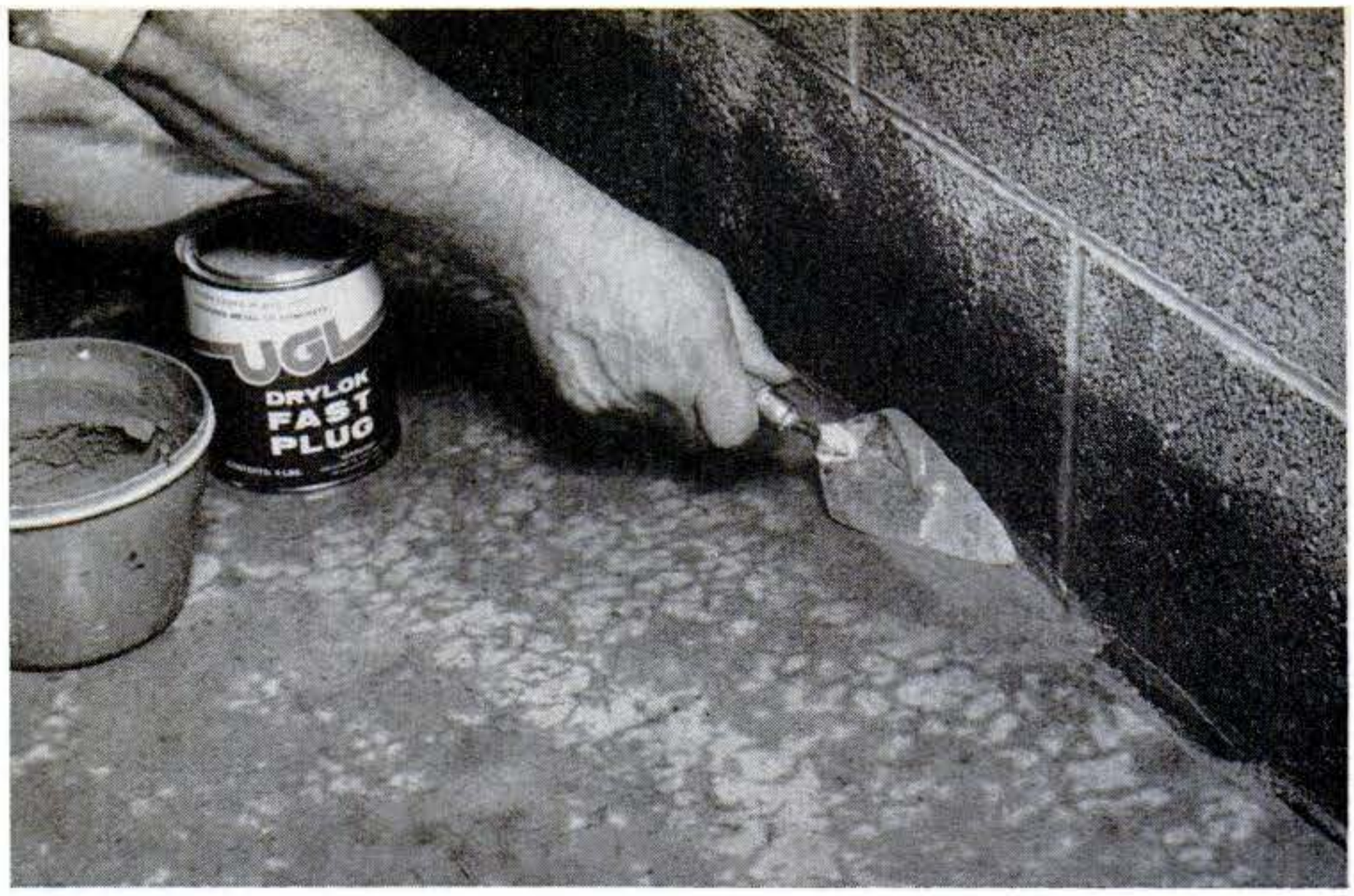
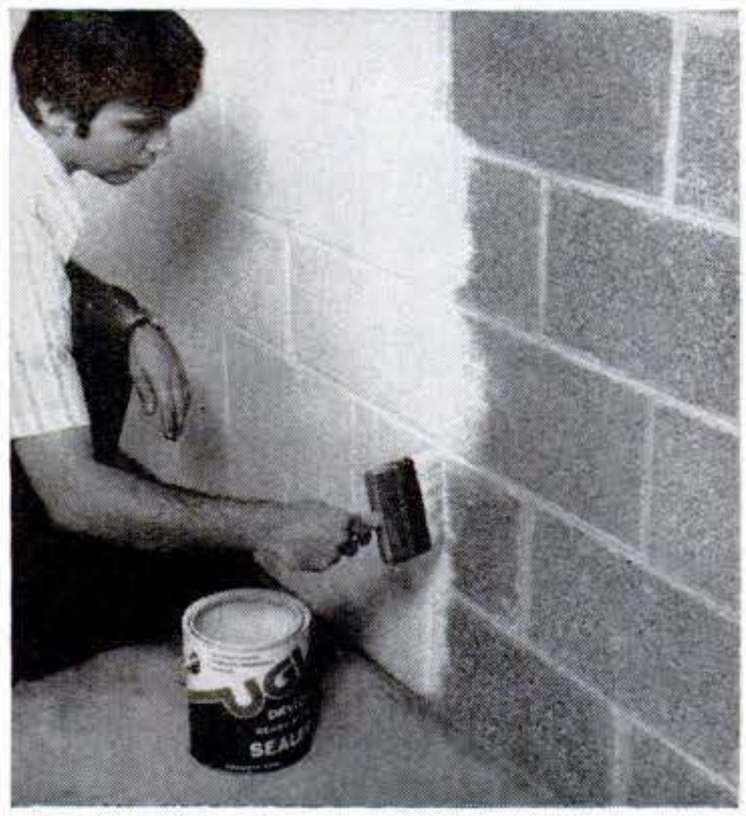


To waterproof wall-floor joint, patch gaps with hydraulic cement (above). To seal foundation walls, work sealer deep into masonry surface (right).



Leak-sealing applications are the key to a **dry basement**

Water in your basement—just another frustrating problem that you have to live with, right?

Wrong. If your foundation walls are basically sound and your area isn't cursed with unusual hydrostatic pressure, there's no reason you can't seal against seepage. You just buy a good sealer-waterproofer especially designed for this job.

The key to success is proper preparation before you apply. Masonry surfaces must be clean and free of dust, oil, loose paint, or frost. Cracks and holes must be patched with a fast-setting hydraulic cement (top photo).

If your walls are crusted with salt-like deposits, those too must be removed. With a broom or fiber brush, apply a commercial preparation (such as Drylok Etch, made by United Gilsonite Laboratories), or use a 20-percent solution of muriatic acid (one part acid to four parts water). Be sure to leave either solution on the wall for at least a half hour, then rinse thoroughly with water and let dry.

As a final check, reinspect the walls carefully to make sure you've not overlooked any dirty patches, small cracks, or crusty deposits. Remember, wall preparation is crucial if your basement is to be completely waterproofed.

Now you can apply sealer. Mix powdered sealers according to manufacturer's directions, then thoroughly wet the walls before applying.

If you use a premixed sealer (like the Ready Mixed Drylok in our photo), you can skip wetting the walls. Just make sure air and wall temperature is 50°F or higher, then apply the sealer directly from the can. Brush the first coat on, working it into the pores of the masonry. For normal waterproofing, one coat is usually all that's needed. But if your basement chronically suffers from excessive leaking, a second coat ensures that all pores or pinholes in the masonry are covered. Let the first coat dry overnight, then apply the second with a roller or spray gun, if you wish.

Then sit back and wait for the next heavy rain. PS

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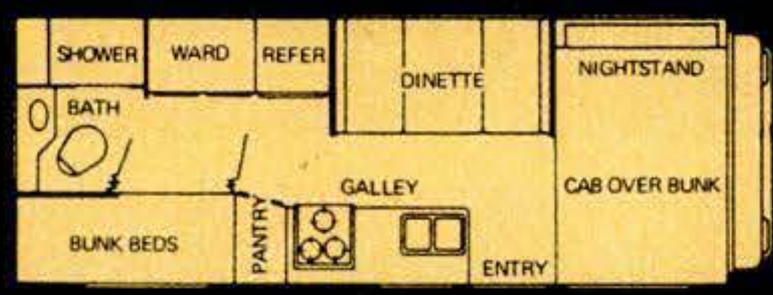

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Super racket

[Continued from page 46]

This insight was gained when Head conducted a series of tests to determine the coefficient of restitution (c.o.r.) at various points on the Prince and conventional rackets—in effect, a measure of the size of the sweet spot and location of the center of percussion. As a consultant, Head hired Kenneth Wright, a mechanical engineer with the physics department of Princeton University. Together, they fired tennis balls at vise-held rackets and recorded the results with high-speed cameras. The results are shown in the diagram on the first page of this article.

Engineering results aside, how does the Prince racket play? The answer, of course, is subjective—and therefore decidedly controversial. Howard Head told me that the more accomplished a player is, the longer it takes to adjust to the Prince. That's because the pros are grooved: They're tuned to hit the sweet spot on *their* racket—wherever that spot is. Conversely, it seems that beginning to intermediate players—"hackers" like myself—are the ones most likely to benefit from the Prince. Head estimates, though, that the Prince can gain even top-flight players a decisive two or three extra points per set.

I have played with the Prince and found that in a short time I got used to hitting the ball somewhat farther down from the tip of the racket. I like the results I've been getting. And there's one place on the court where the racket makes a tremendous difference, especially if you're not that expert—at the net. I know many players who either avoid playing net or cringe when they're forced to, simply out of fear of getting a ball rammed down the gullet. The extra 50-percent surface area of the Prince not only gives you a lot more protection, but lets you block a lot more shots at the net.

I can now hear a chorus of voices chirping: "Simply to make a racket with a bigger head is no big deal—why, anyone could have thought of that!" The same thing has been said of many past inventions that profoundly changed the way we do things. Whether the Prince racket will indeed change the shape of things to come in tennis is unknowable now. But there is one suggestive augury: Patent No. 3,999,756, which the U.S. Patent Office awarded Howard Head last December, covers a whole envelope of "big-head" shapes. It may be the broadest tennis-racket patent ever granted. PS

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The North Sea is one of the most forbidding spots on earth to drill for oil. Even on a nice day like today.

For years, experts believed a major oil field was buried beneath the North Sea. But even if they could find the oil, they weren't sure they could get it out. Especially during stormy winter months when gale force winds and eighty-foot waves made operations even more hazardous.

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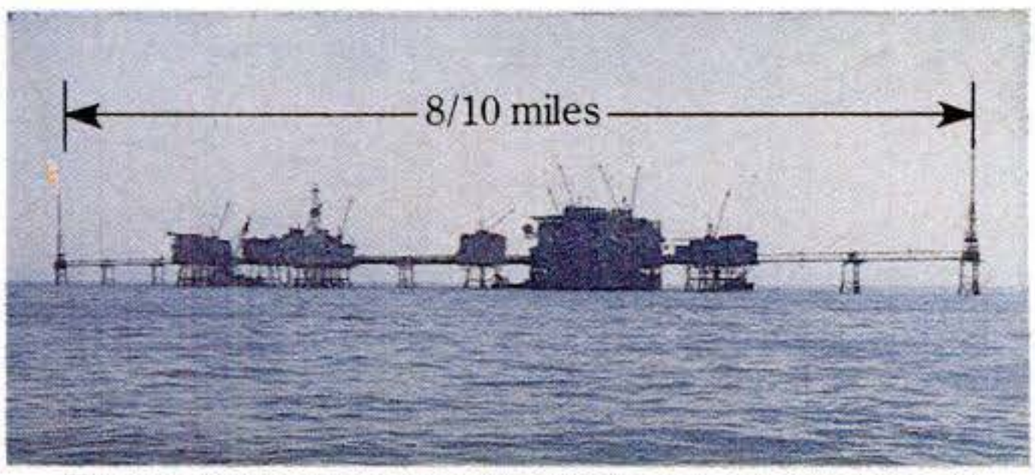

The vast sea makes even the 13-story tower look small.

A city so far reaching, a satellite communications system must be used to link its most distant points.

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But even more important than what's gone into Ekofisk is what we're getting out of it: sorely needed oil and natural gas from a place where it could never be produced before.

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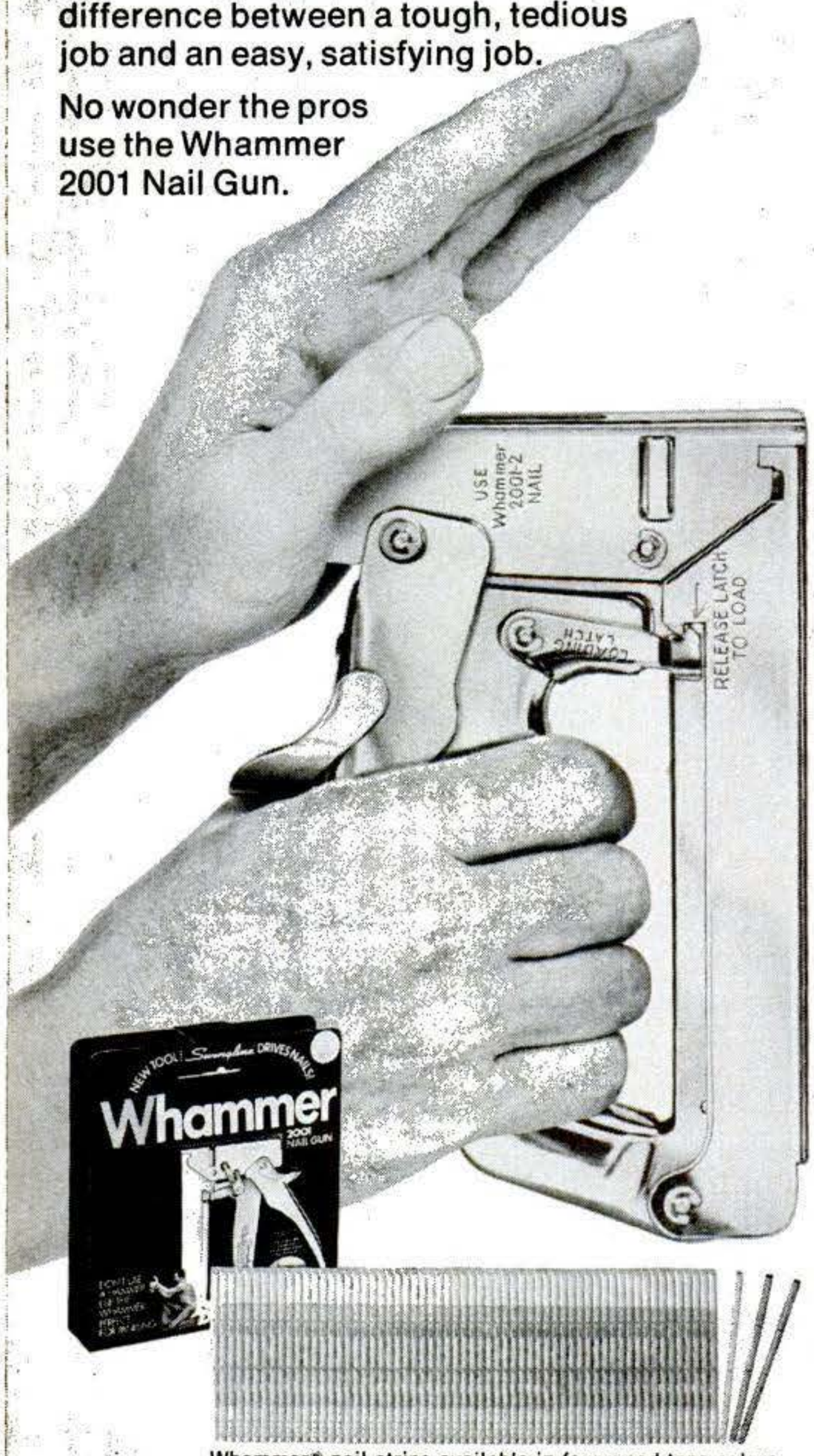

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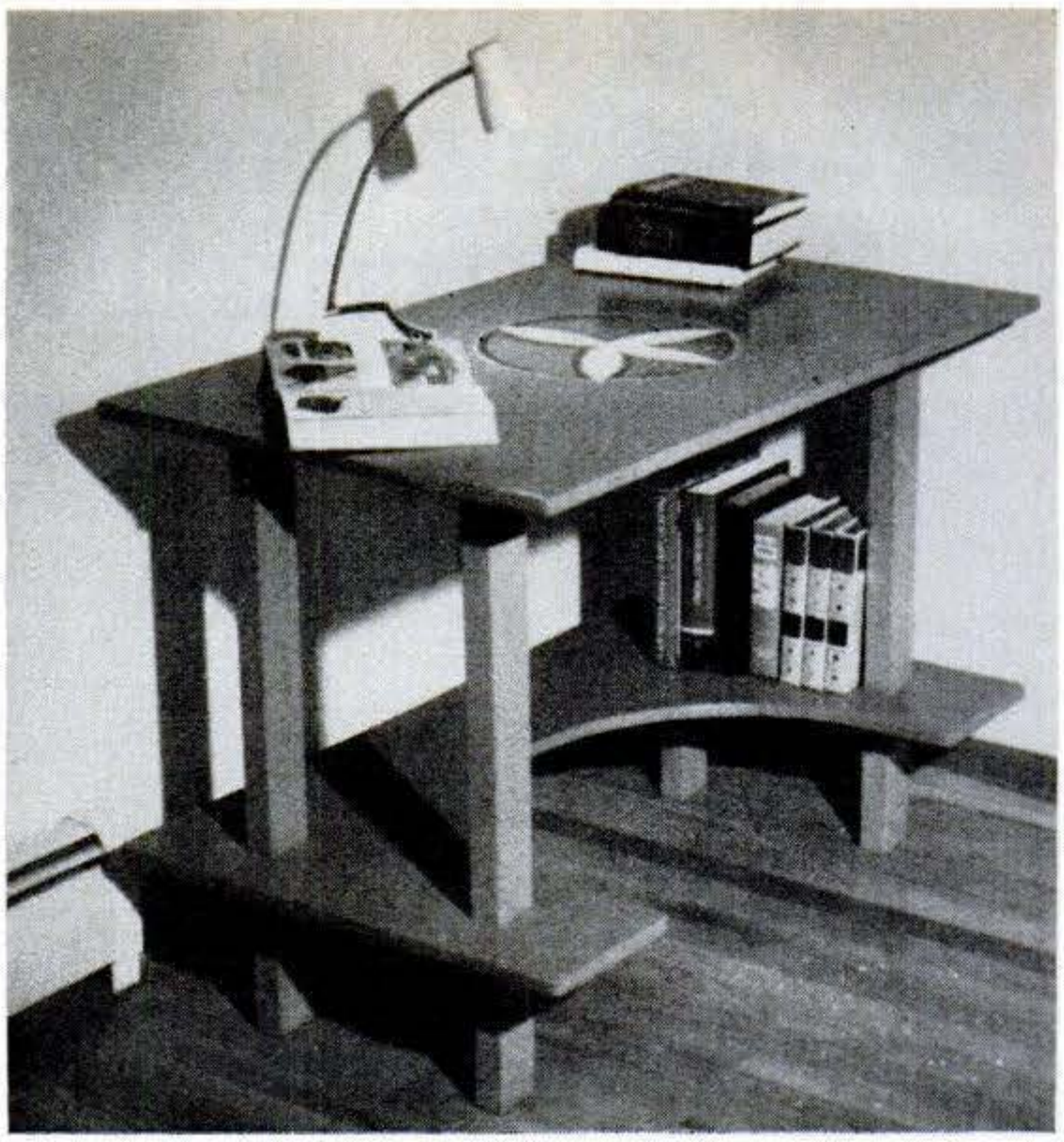
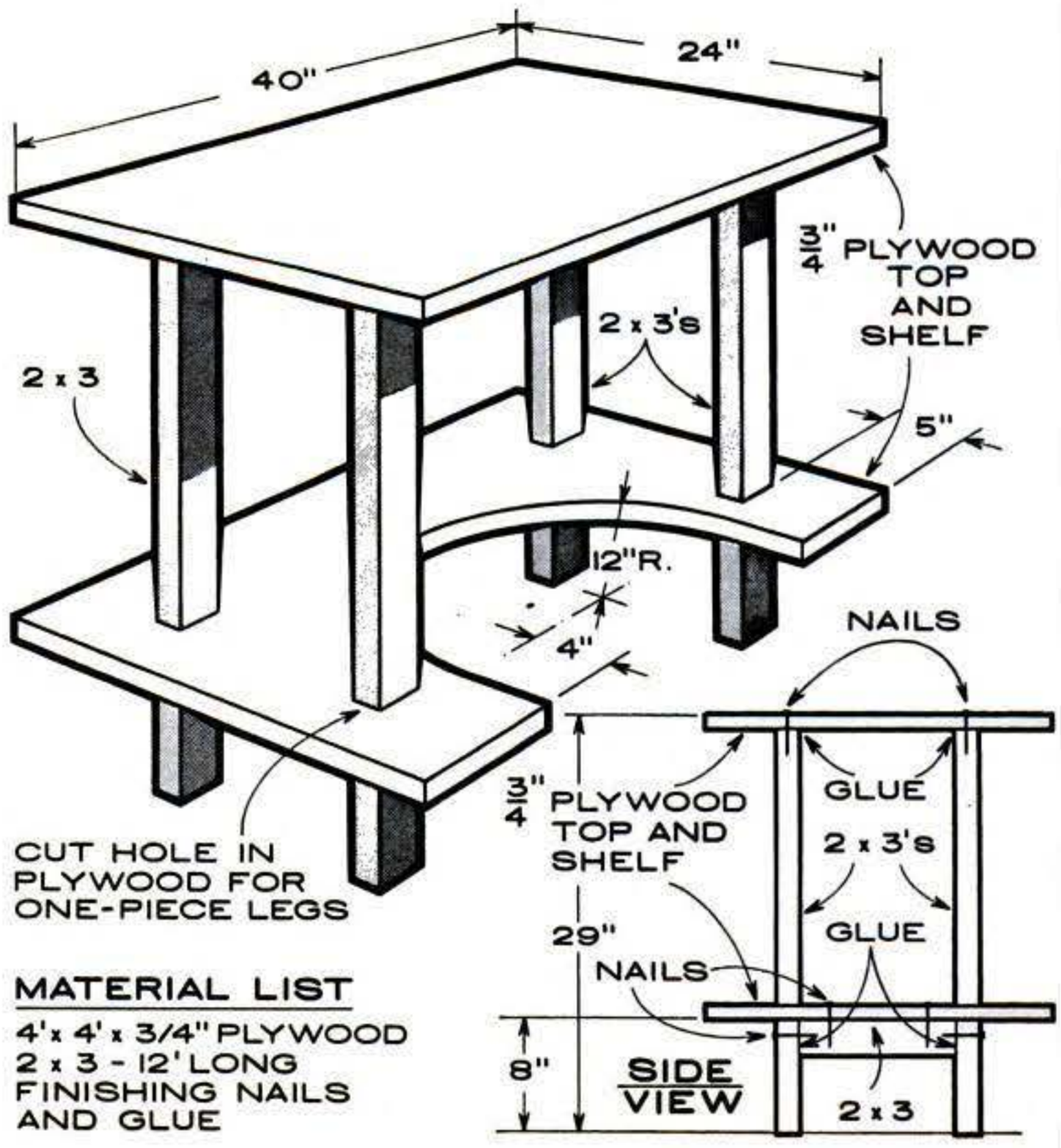


Desk you can build in one evening

Here's a sturdy little desk you can build quickly and inexpensively. Cut two panels of plywood 24″ by 40″, and saber-saw a circular cutout in one for chair space. Cut rectangular holes in this same panel for the 2-by-3 legs. Push legs through holes; nail and glue top in place. Cut a length of 2-by-3 to fit snugly between the legs and under the shelf (front to back only); nail and glue to support the shelf at the proper height. Countersink finishing nails and fill holes with plastic wood. You'll need only half a sheet of ¾″ plywood, 12′ of 2-by-3 studding, finishing nails, glue, and paint.—*James A. Birk*



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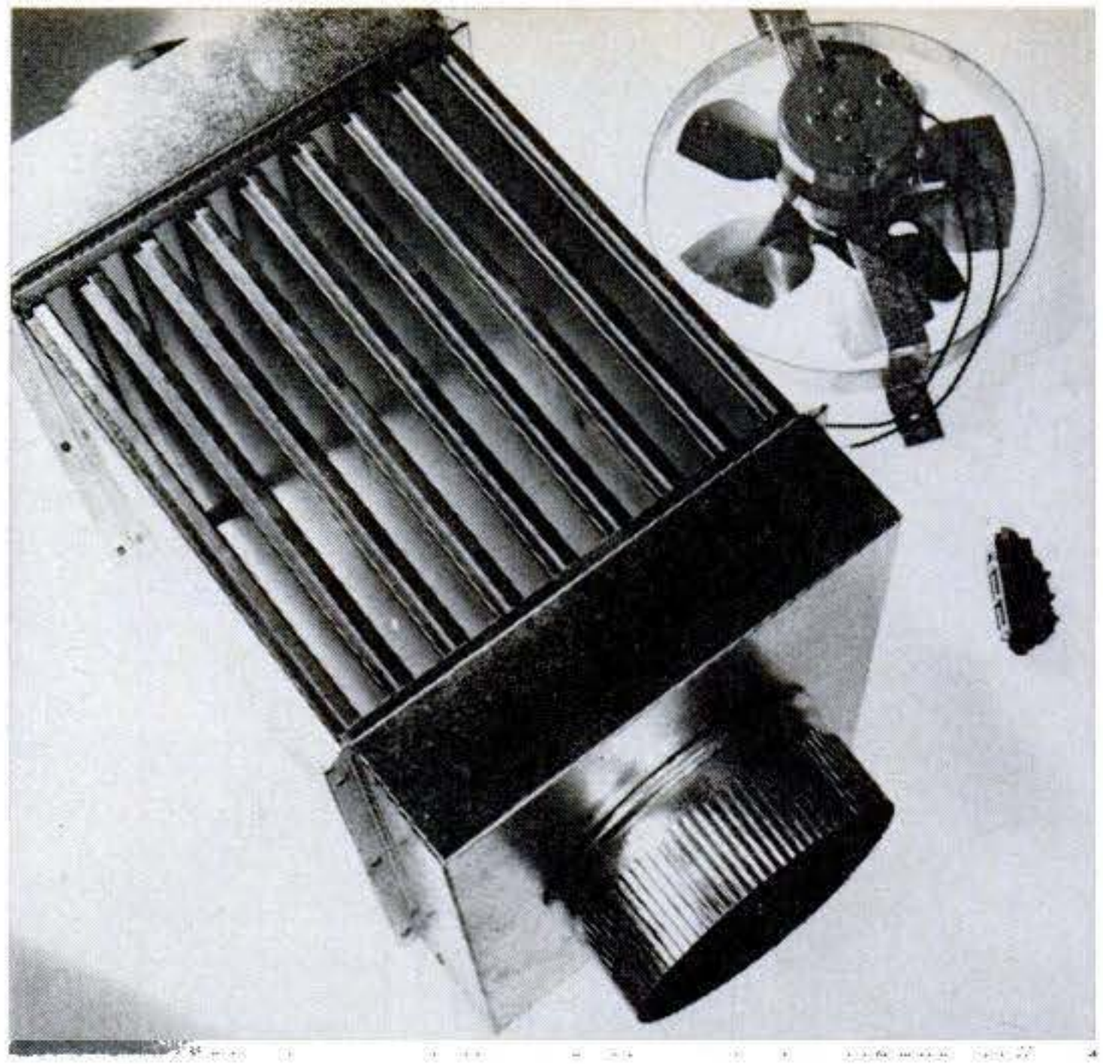
Flue radiator reclaims stack heat



Fan and thermostat for radiator come unmounted. Unit fits any flue size up to and including 8", can be mounted horizontally or vertically.

Simple in design and easy to install, this flue radiator reclaims heat lost up the chimney. Despite possible complications [PS, Mar. '76], reclaimed stack heat is an inexpensive source of heat for your basement, and it can warm your floors and upstairs living area, too.

Remove one section of smoke pipe ahead of the draft diverter on a gas-fired furnace or the barometric damper on an oil-fired furnace, and install the radiator in its place. An adjustable 115-volt thermostat and fan are held in place by sheet-metal screws. To install, you just drill four pilot holes and run a 16-ga. wire to an outlet.

The surface-mounted thermostat is affected by both stack heat and ambient temperature. Finding the temperature range for the room area and maintaining automatic fan operation as the stack heats and cools will take some experimentation. Following the manufacturer's recommendation, I initially set the thermostat at 110°, then gradually moved it up and down as needed: 98° turned out to be my optimum setting.

To insure that your burner and draft control are adjusted to maximum efficiency, I recommend you have a pro check your installation with combustion instruments. Mine needed no adjustment.

The flue radiator provides a generous amount of heat, but I have two complaints: The fan is unguarded and the thermostat wiring terminals are exposed. Install the fan away from any place where unsuspecting fingers might reach, or make a protective guard from a two-foot square of hardware cloth.

To enclose the wiring connections, I formed a sheet-metal box to fit the top of the thermostat at its mounting screws. This left the sensing element exposed (a standard electrical box would impair its heat-sensing capability).

The flue radiator is made by J.H. Stoneberg Mfg. Co., Brockport, Pa. 15832.—*Evan Powell*

Eagle at 30 ft. Photographed by W. Beecher with the Celestron 1250mm, f/10 Multipurpose Telephoto Lens.

Saturn's Rings. Photographed with Celestron 14 Telescope.

Orion Nebula
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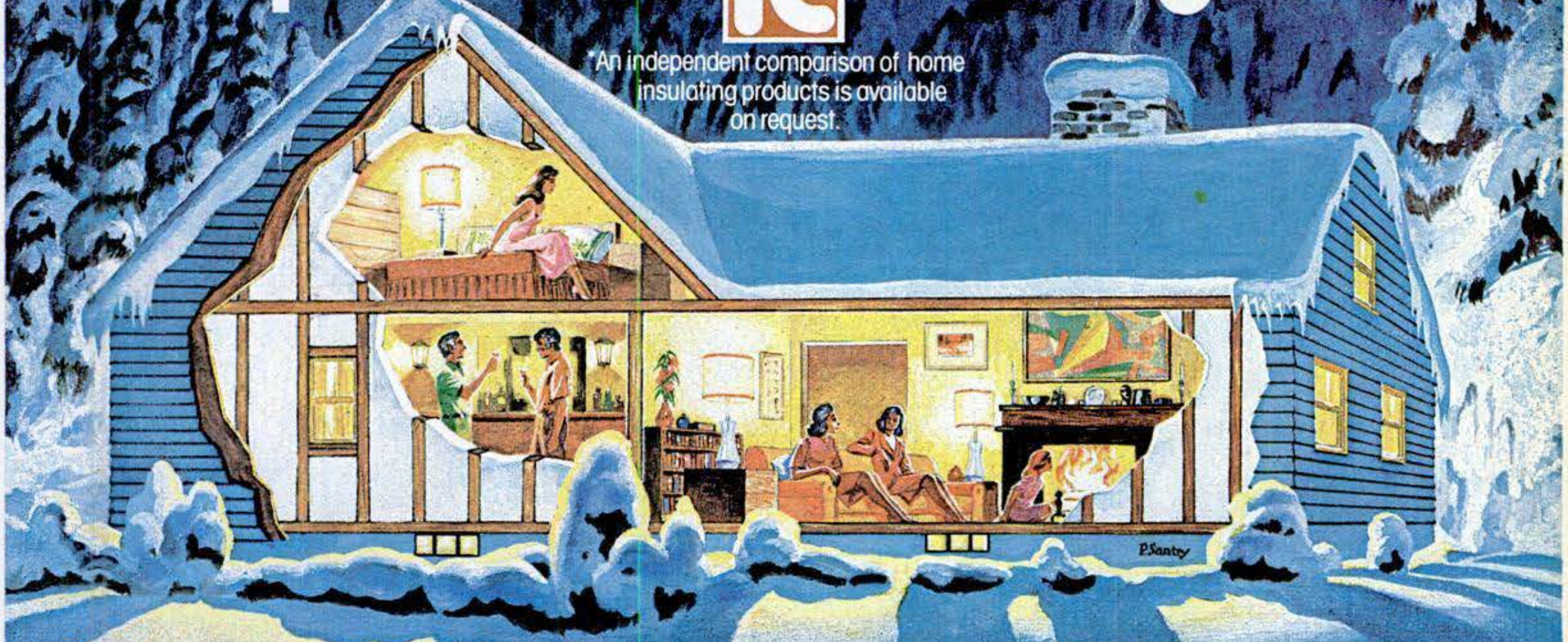

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Stepped trailer hitch puts you on the level

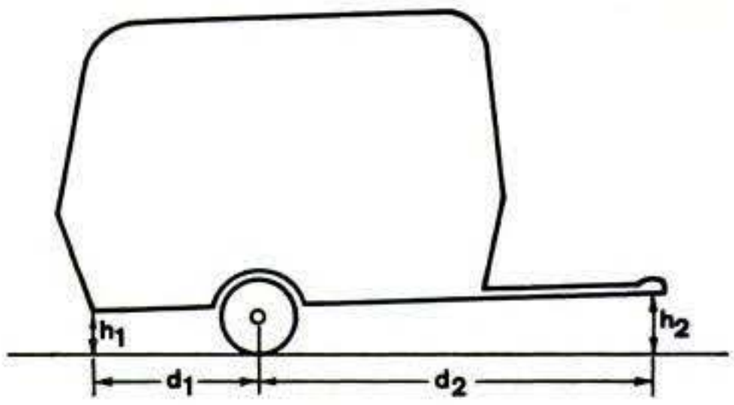
BEFORE

AFTER

A step bumper is a handy accessory on a pickup or 4WD vehicle. And it's hard to beat for attaching a hitch for small trailers—providing its height doesn't give your trailer a case of the tilts. If you have a bumper-altitude problem, you can do as we did: make a custom hitch that will lower your coupler.

The first problem is to determine how much the tongue needs to be dropped to level the trailer. You could find out the hard way: Level your trailer on a slopeless slab and measure from concrete to coupler. But with this algebra formula you can do the work on paper: Desired tongue drop (see diagram) =

$$\frac{h_2 - h_1}{1 + \frac{d_1}{d_2}}$$



Example: If the trailer is 60 inches from rear to axle and 120 inches from axle to coupler, then $d_1 = 60$ and $d_2 = 120$. If frame clearance is 10 inches at the rear and 18 inches at the coupler, then $h_1 = 10$ and $h_2 = 18$.

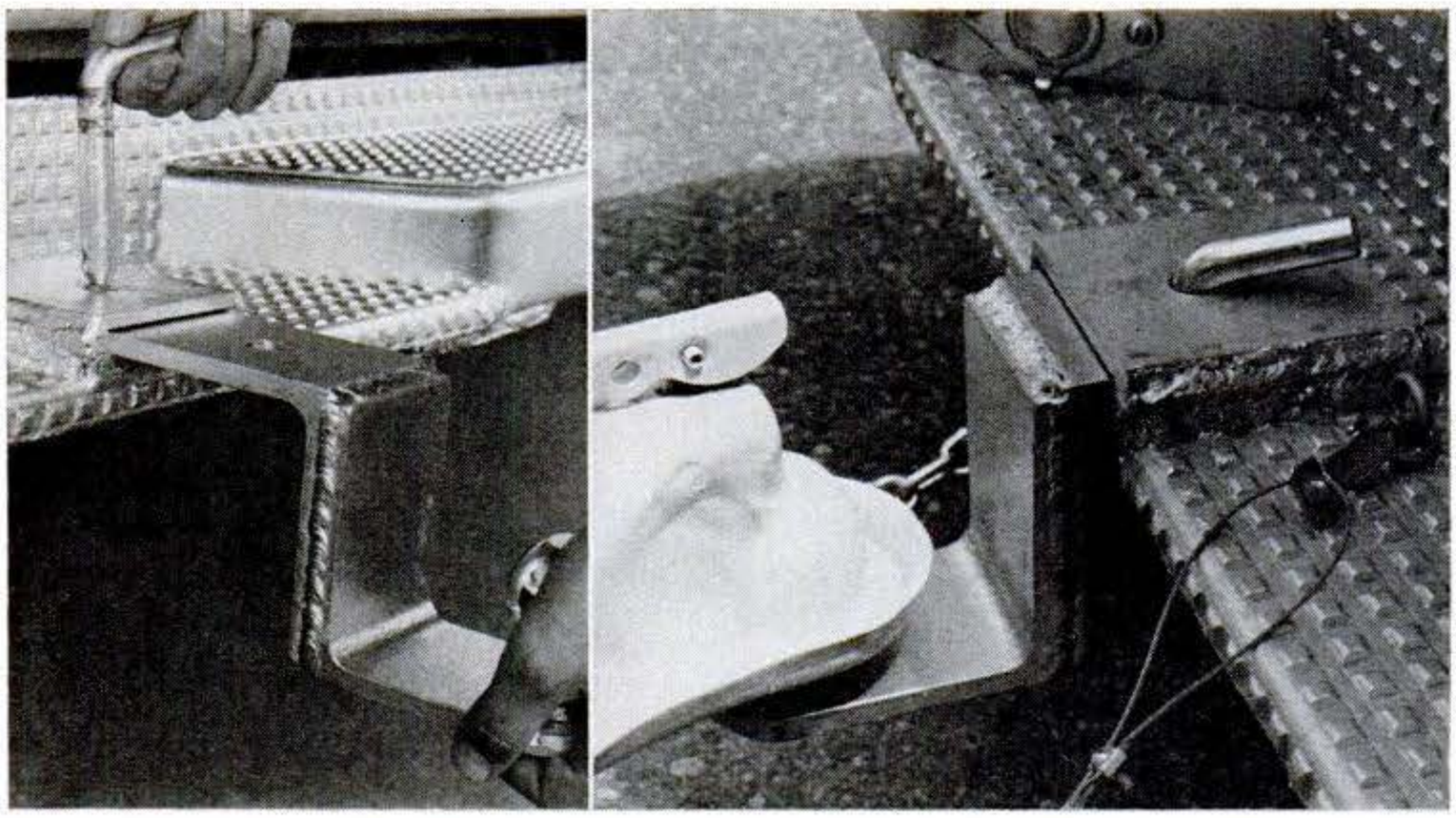
To eliminate the eight-inch difference, drop the coupler:

$$\frac{18 - 10}{1 + \frac{60}{120}} = \frac{8}{1 + 0.5} = 5.33 \text{ in.}$$

Once we figured out what was needed, we had a machinist construct a slot receptacle on the top of the bumper to accommodate a removable stepdown ball assembly. (We wanted it removable to avoid sacrificing ground clearance when the trailer was not being towed.) The slot is 3/8" by 3-3/16" and extends four inches forward from the rear of the bumper. An 11/16" hole through the receiver and the step bumper permits downward insertion of a hefty pin that holds the ball assembly in the receiver slot.

The ball assembly is made from two slices of five-inch angle stock 3/8" thick. The two are securely welded back-to-back, one flange at the bottom, the other at the top. An 11/16" hole in one flange accommodates the hitch pin; the trailer ball mounts through a 3/4" hole drilled in the other flange.

Cost was $40 for fabrication and $5 for the hitch pin and retainer—*Sid and Marge Stall*



Removable stepped trailer hitch is made of two pieces of angle stock welded together, stairstep fashion. Trailer couples to ball in conventional manner.

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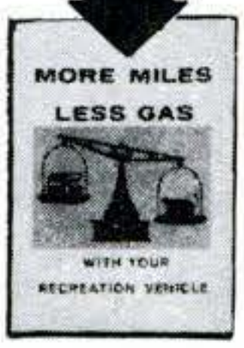

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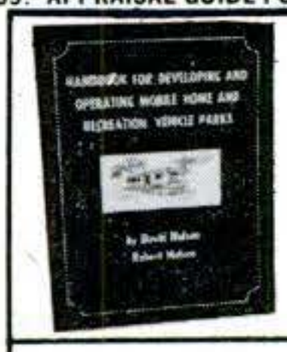

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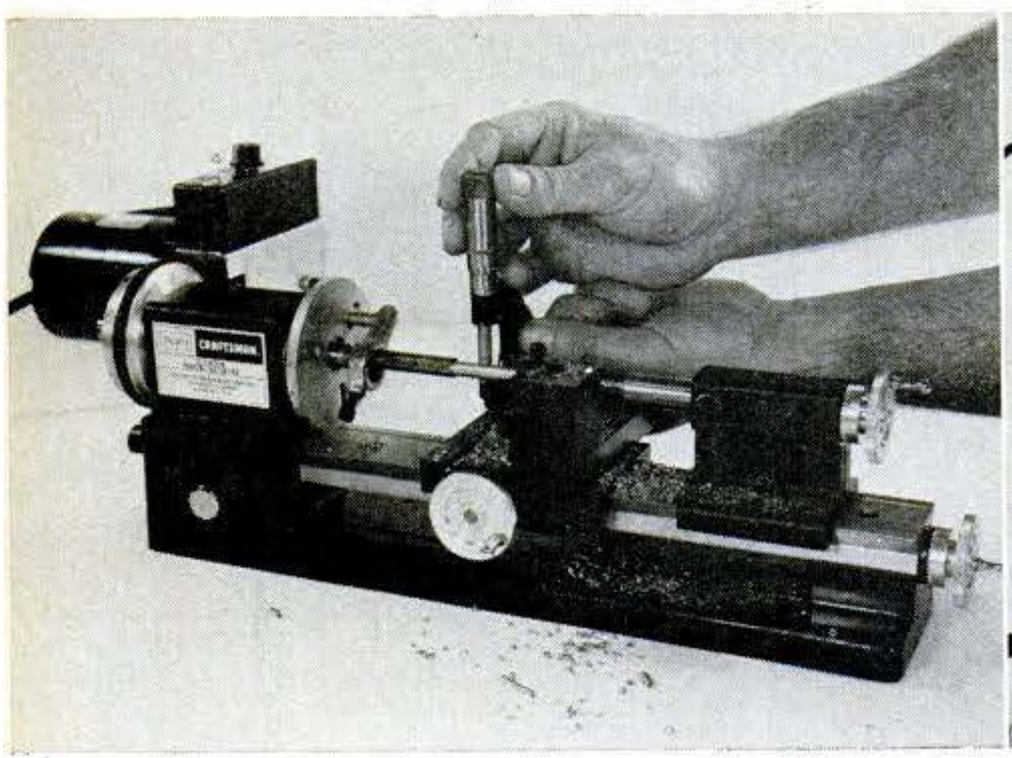
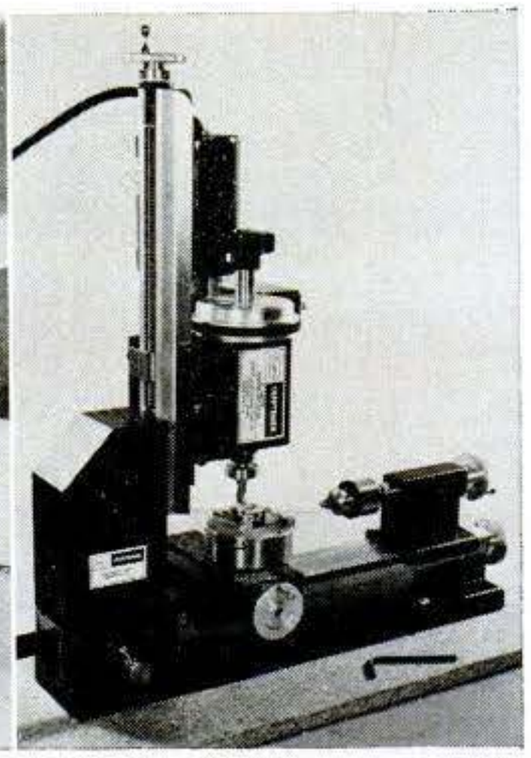




Basic lathe will handle work between centers (left) or clamped to faceplate. Machine is capable of half-thousandths accuracy. Dials are easily read to that setting. Vertical milling attachment (right) works dandy, but you'll need a small vise to hold work. Here, part is held in three-jaw chuck.

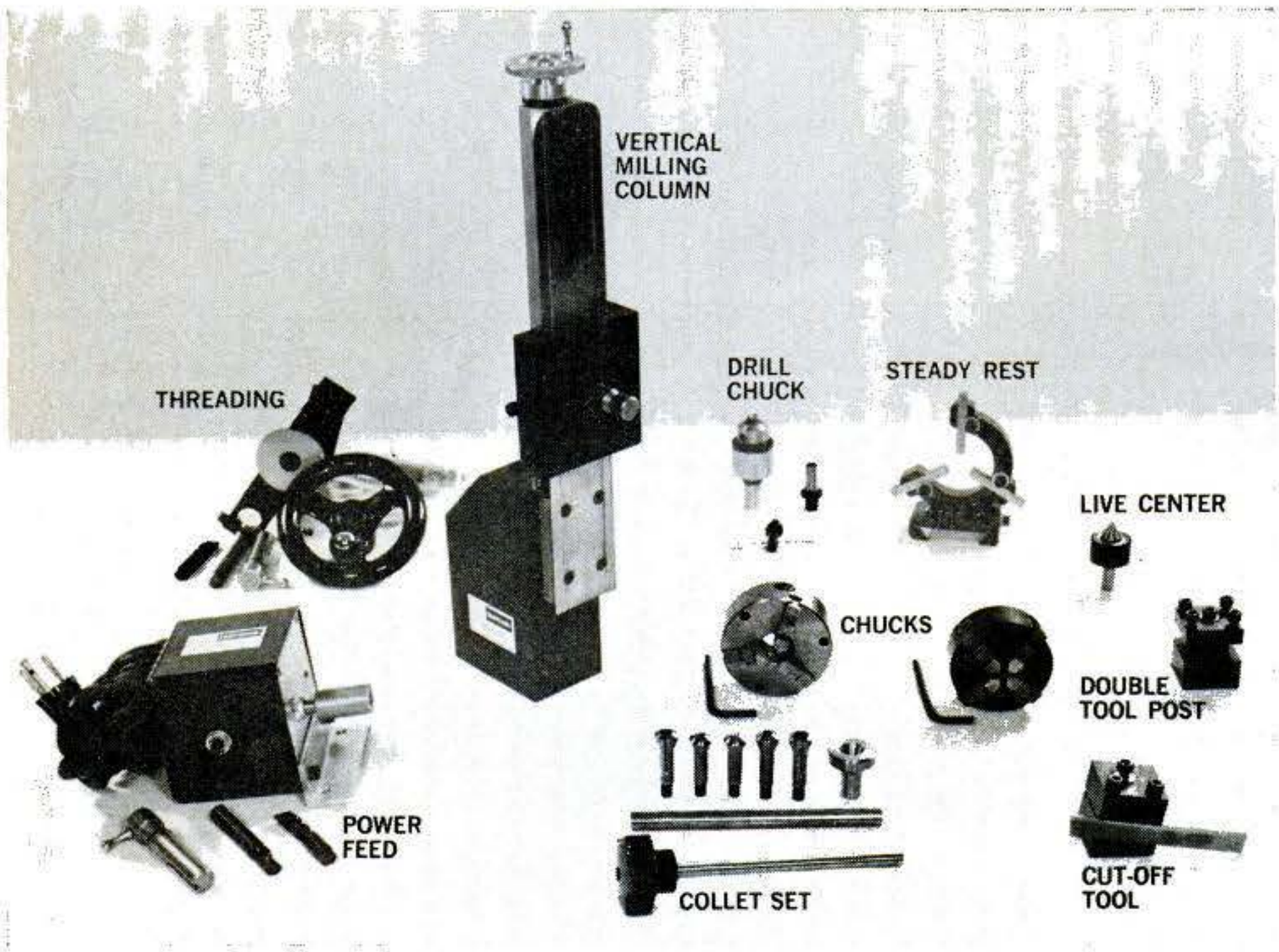
Little lathe for metal cutting

If workspace is limited, if your work is small, or if you want to learn basic machining, you'd do well to look at Sears' new compact metal-cutting lathe.

Its obvious rival is the popular Unimat. In some ways the two are similar: At $199.95, the price of the Sears lathe is close to the Unimat's. The Sears lathe takes 8″ between centers, a bit over an inch more than the Unimat. It swings 3½″ over the bed, again a bit more than Unimat, and its variable-speed motor is rated at ⅛ hp, as compared to Unimat's 1/10-hp single-speed, belt-change drive system.

There the comparison pretty much ends. The American-made Sears lathe is essentially a cleverly scaled-down "conventional" lathe design with a fully gibbed, precision-ground V bedway and slides and standard Morse taper holes in the headstock and tailstock.

The lathe is superbly finished. Handwheels are relatively large and easy to read. The 2⅜″-dia. three- and four-jaw chucks are little jewels. The collets are standard industrial quality. Cutting off is made simple with a special holder and cut-off blade assembly. The variable-speed drive works fine, and power is adequate for normal operations.—*Mack Philips*



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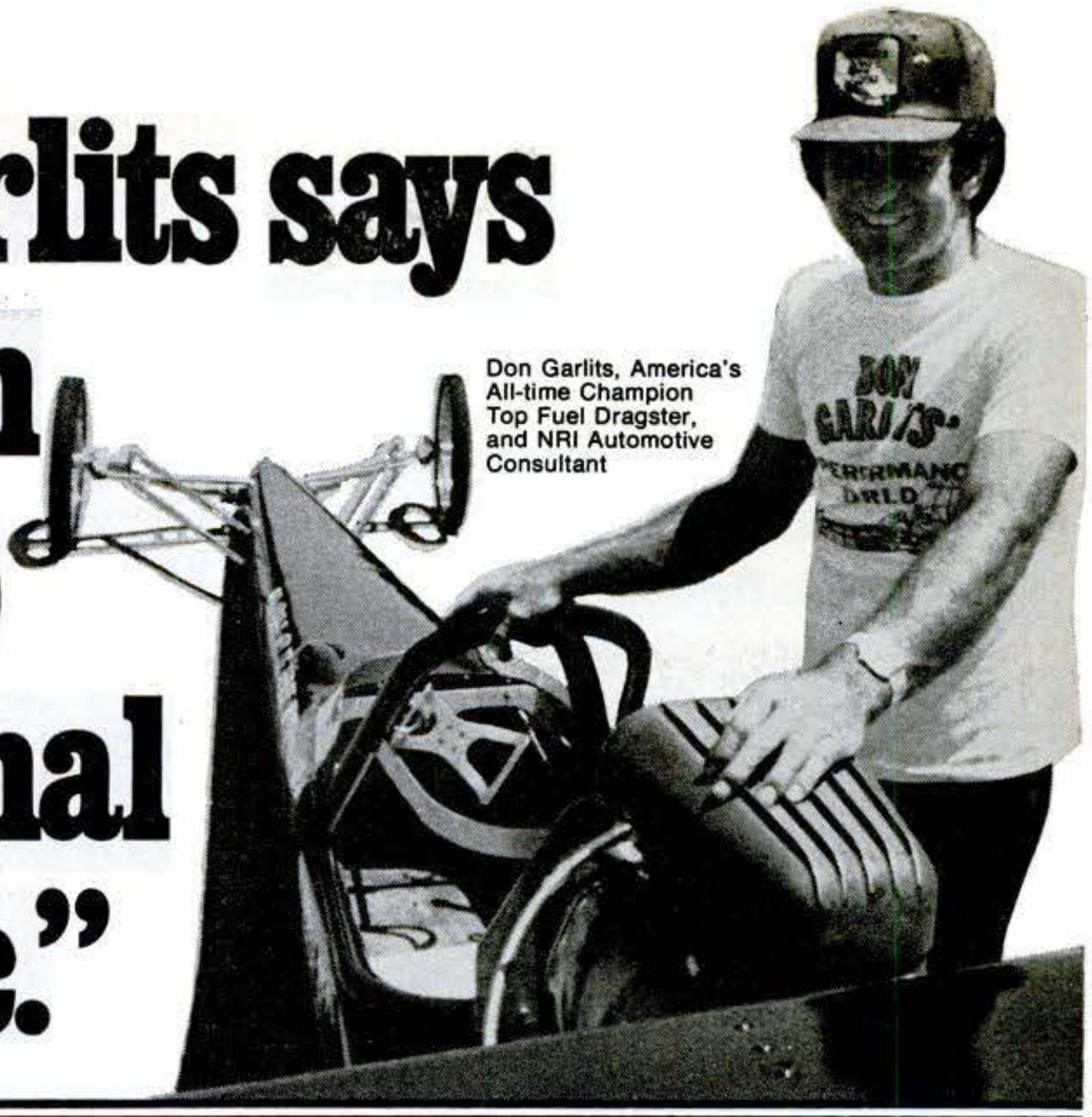

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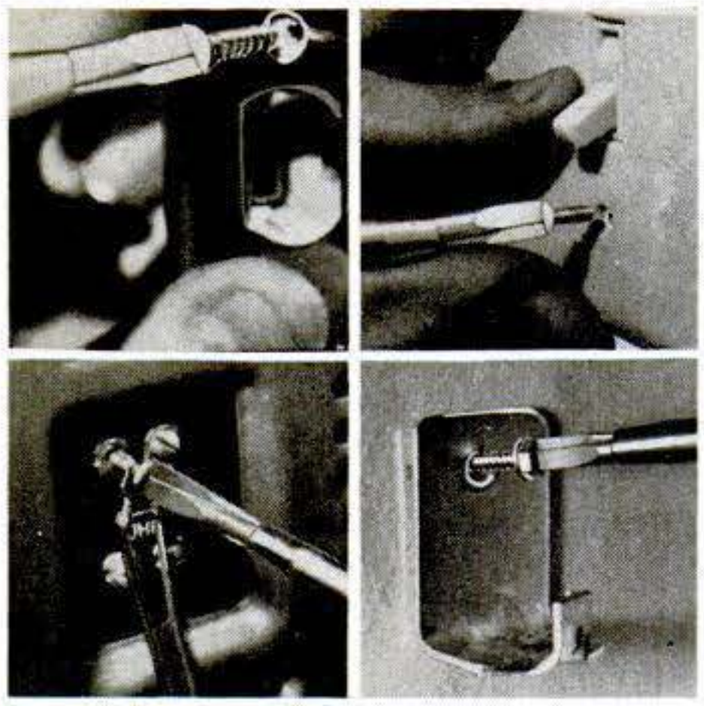

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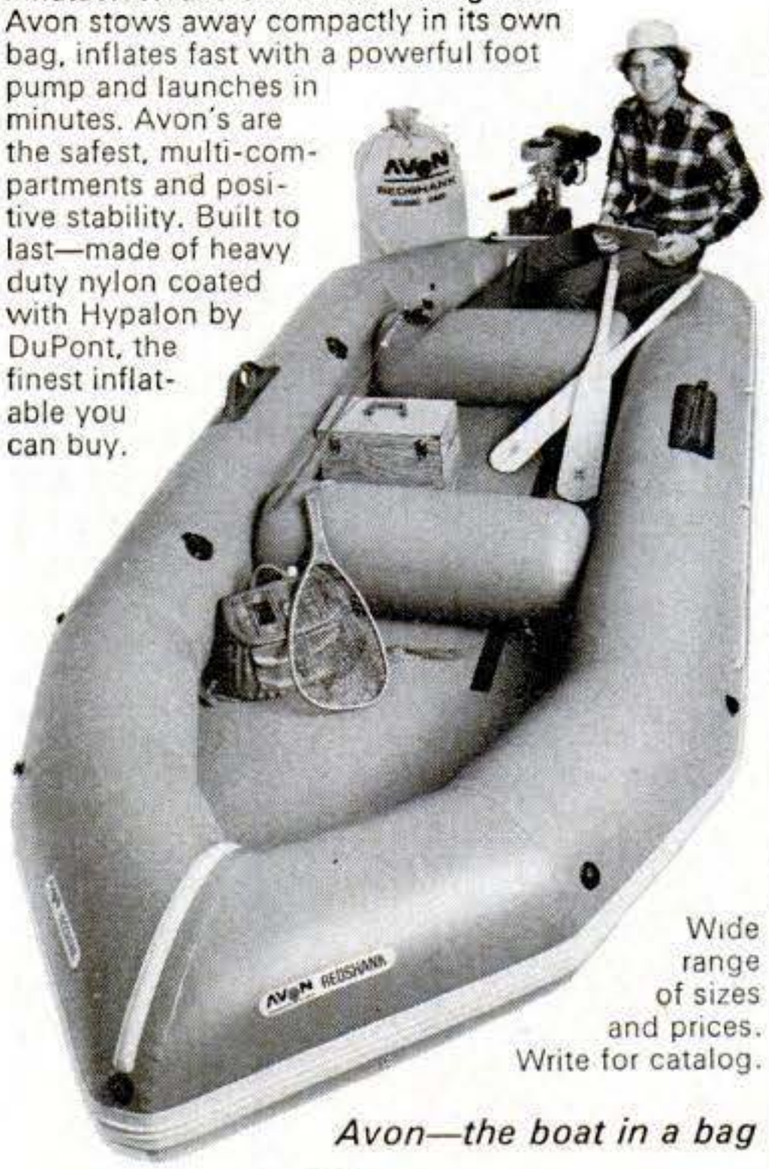

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Skewed-prow leisure home

[Continued from page 113]

ever, boasts a second story, with the largest of the three bedrooms, a second bath, plus handy eaves storage along both sides.

The asymmetrical roof rises from the ground at a steep pitch on one side (enclosing the utilities beside the laundry room); the other side of the roof starts from the window head at a lesser slope. This aligns the ridge with the peak of the prow and adds design interest, as do the exposed rafters and tie-beams.

The central entrance foyer inside a covered porch is another unexpected touch. Many leisure homes lack any formal, sheltered entry.

The deck access to the fully equipped kitchen invites outdoor dining. And it's easy to carry in groceries from the other direction, since the kitchen is opposite the entry.

Also directly accessible from that foyer is the broad balcony, which could easily become the favorite space in the house. Measuring about nine feet wide by 21 feet long, it can serve as an upstairs lounge for reading, a play area for rainy days, or—equipped with a convertible sofa—could double as an extra guest room (the upstairs bath would be shared). Whatever its function, it affords the best view in the house.

Exterior finish materials can be left unpainted for a rustic effect—wood shingles on the roof, walls of natural wood siding. The same wood is carried inside to become the side-wall paneling. The exposed roof deck high above and the plank flooring underfoot complete this effect.

The house was designed especially for our PS series by architect Samuel Paul, who tells us he particularly enjoys doing leisure homes. Prices for a single set of blueprints, or four duplicate sets, are listed below. If you want still more sets, you can get them for $17 each with your original order.—*Al Lees*

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One set of detailed, professionally drawn blueprints for the Skewed Prow is $59; four sets (for building, financing, obtaining permits), $75. Materials list and specifications included at no extra cost. Plans can be reversed, side for side, for $10. Address orders or inquiries to Candlewood, Homes for Living, Inc., 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add $3 for first class.

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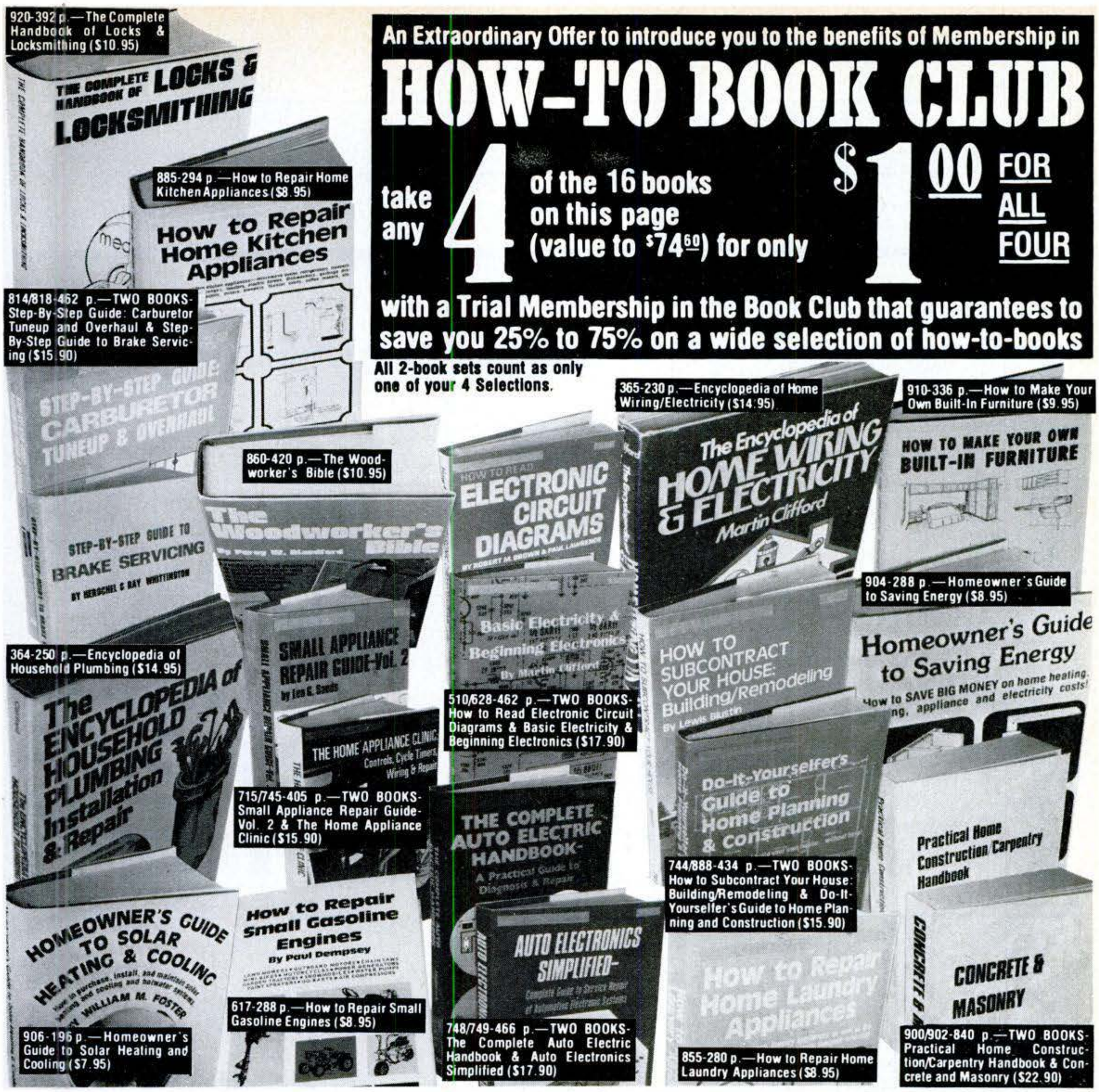

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By ROY DOTY

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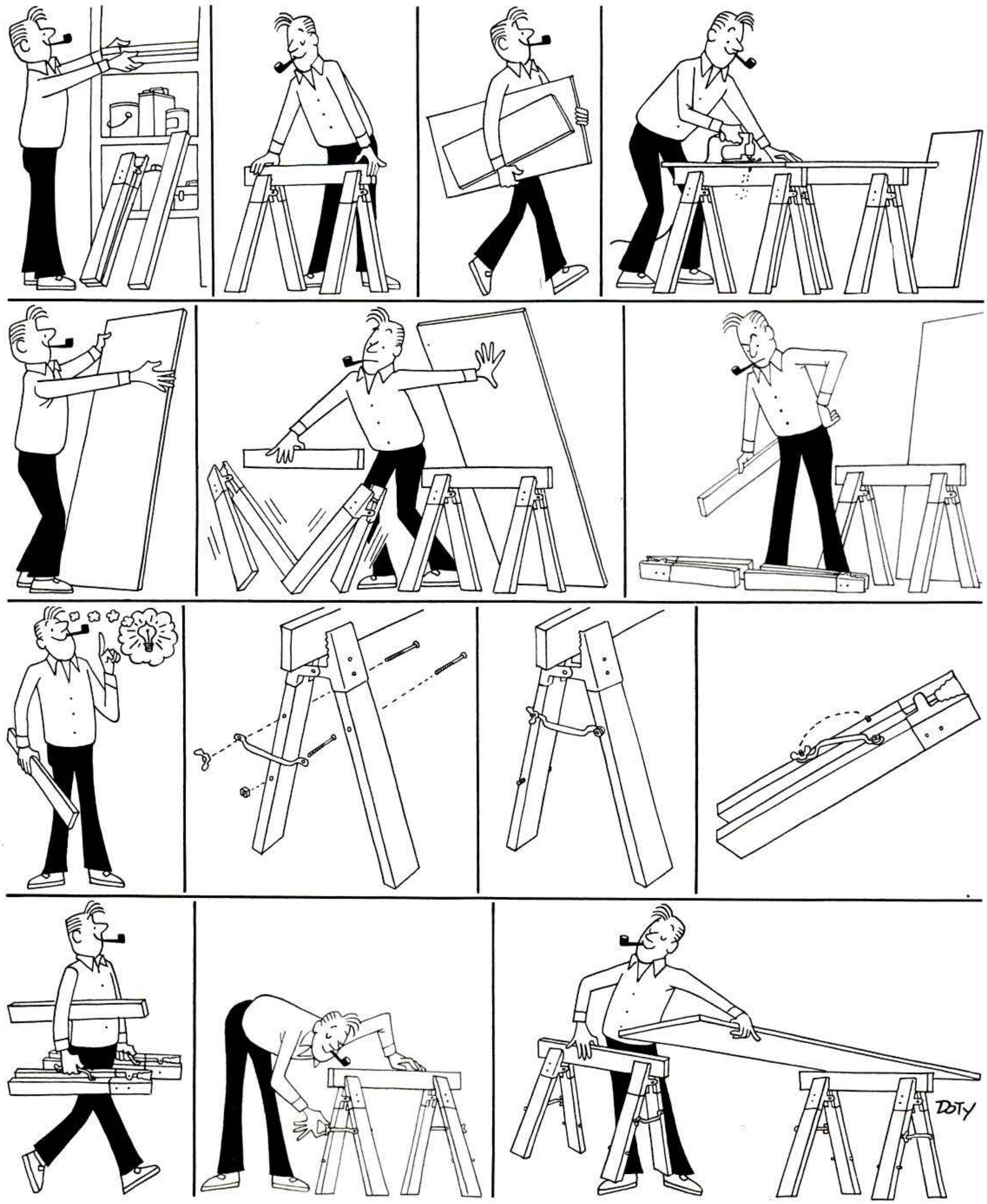

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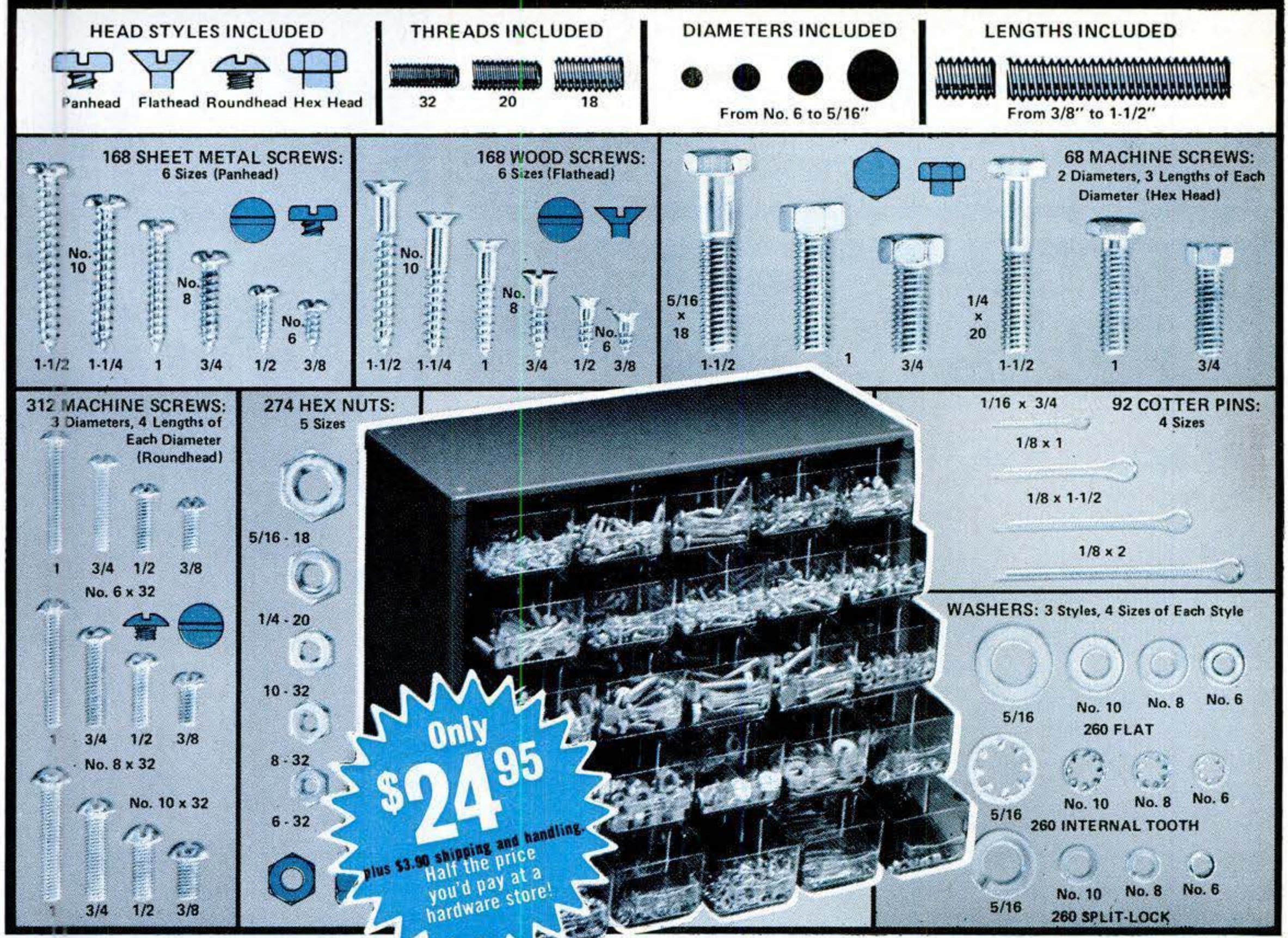

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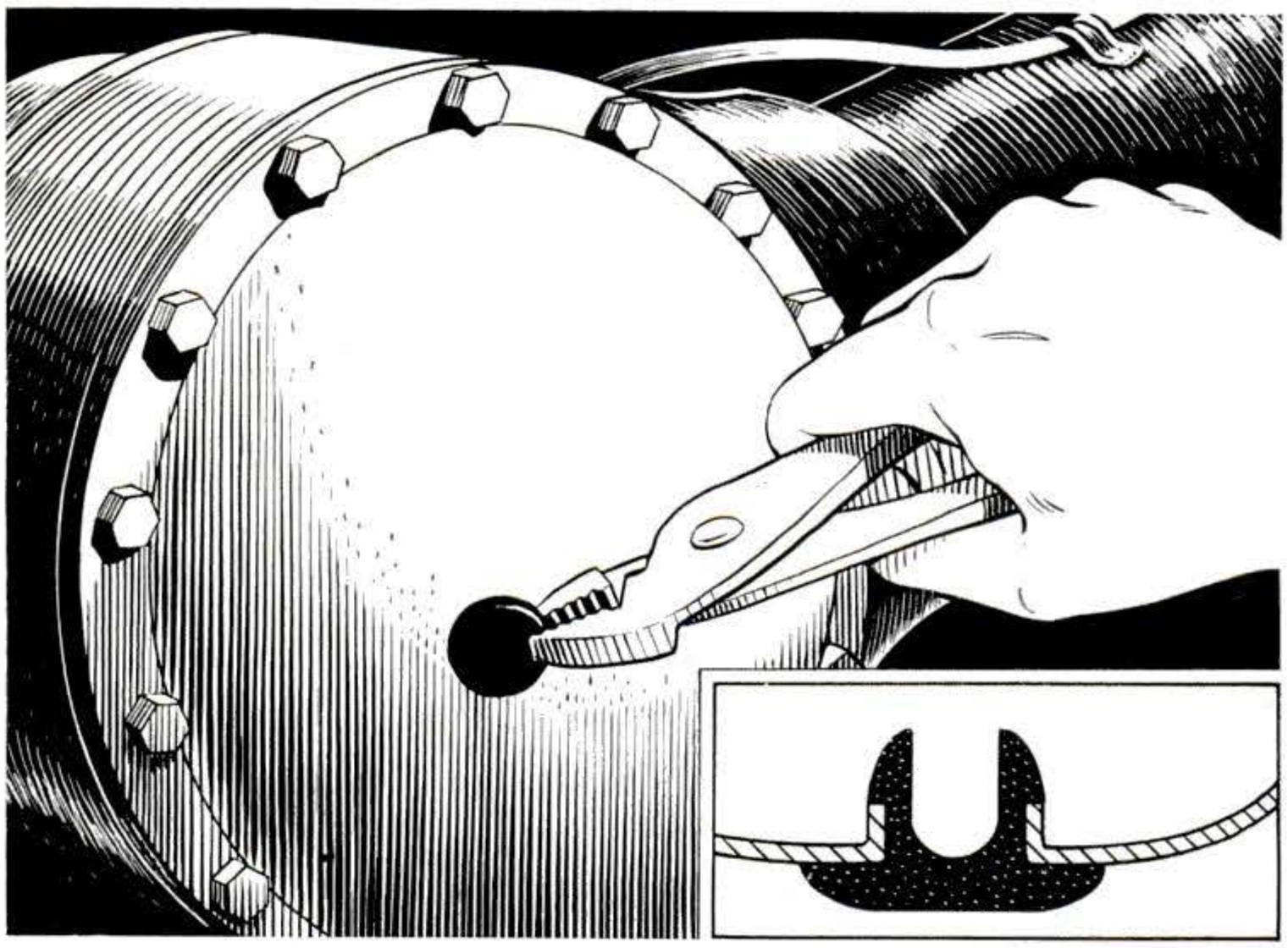
TAKING CARE OF YOUR CAR

By RAY HILL

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.

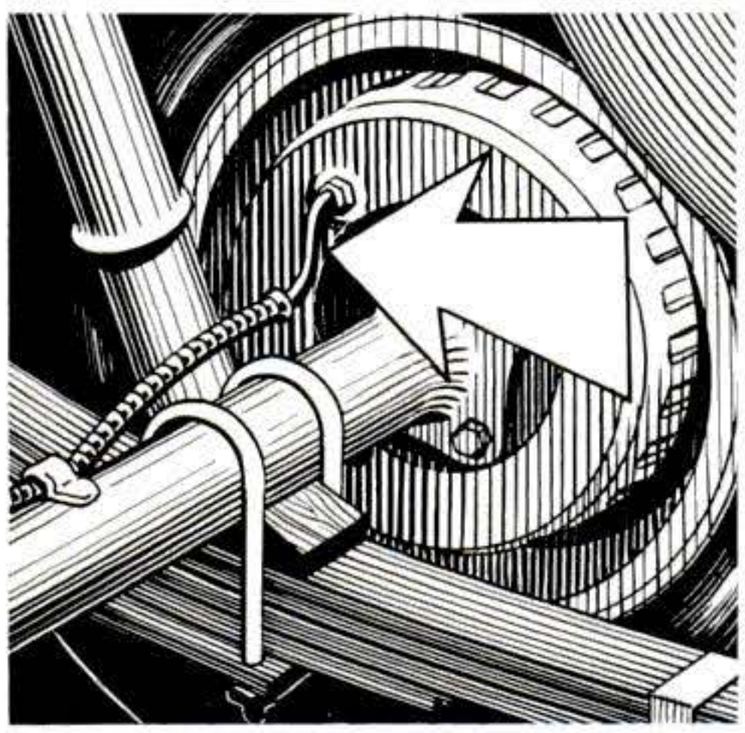


That new axle-cover fill plug may not be what it used to be

Most new Chrysler cars and trucks no longer have a threaded-metal fill plug in the rear-axle cover. Instead, there's a rubber plug that's supposed to be easier to remove and replace. To remove the rubber plug, grip its lip with a pair of pliers and pull it out of the hole. When reinstalling the plug, lubricate the lip, start it into the hole, and then seat it with your thumb or the heel of your hand. If you have an older Chrysler, don't try to replace the metal plug with a rubber one—they're not interchangeable.

Mounting plastic mirrors

Installing a mirror with a plastic base? Don't overtighten it—the base may crack. Too late? You've already cracked the base? You may be able to salvage it by putting epoxy in the crack, then binding the crack shut with duct tape until the epoxy has set.

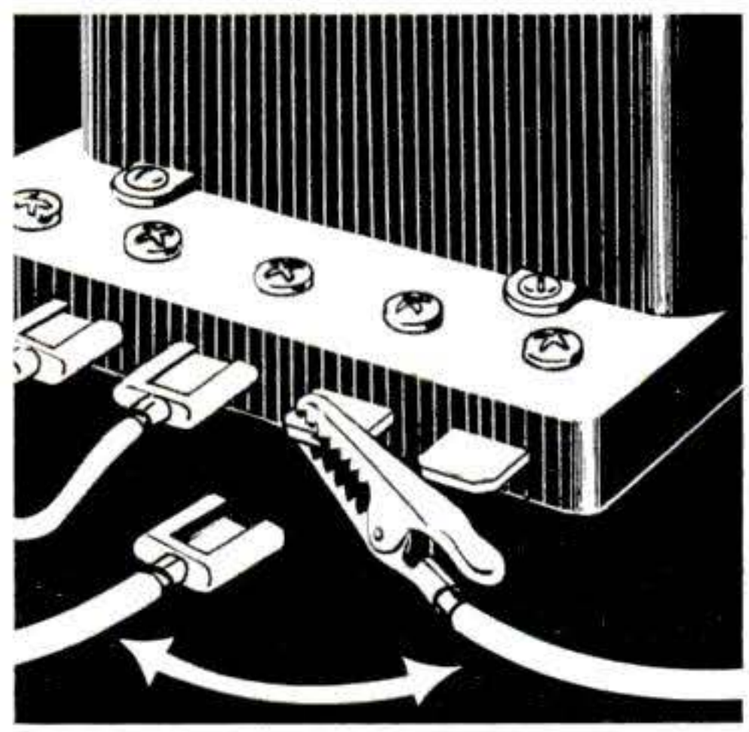


Inspect those brake lines

Regardless of where you live, you should inspect your brake lines at least once a year for signs of rust and corrosion. But this is especially important for older cars driven in areas where salt, chemicals, and abrasives are used to control ice and snow on the highways. Corroded tubing should be replaced immediately. In older cars without a dual braking system, a tubing failure can result in total brake loss.

Check your work

When replacing a leaking valve-cover gasket, don't just tighten the valve cover and close the hood, assuming you've done a perfect job. Even professional mechanics don't always get everything right the first try. Start the engine and let it run a few minutes. Study the gasket carefully, not only in areas where it's easy to see. If there's leakage, loosen the valve cover, reposition the gasket, and check again.



About electrical testing

A jumper wire with an alligator clip on each end can be a useful and time-saving device for electrical testing. When you use one, though, be sure that it is as heavy as the wire in the circuit you're hooked into. If the jumper wire is a lot smaller than the wire in the circuit you're testing, the jumper wire can heat up, and may melt. This can cause electrical damage, and even create a fire hazard.

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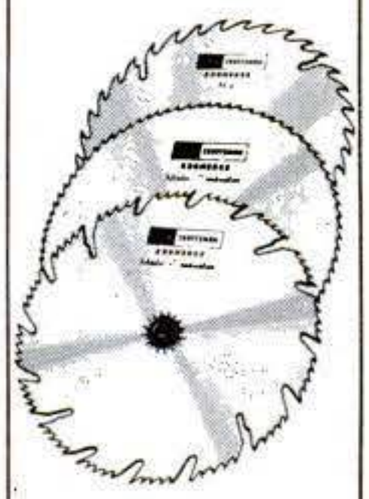

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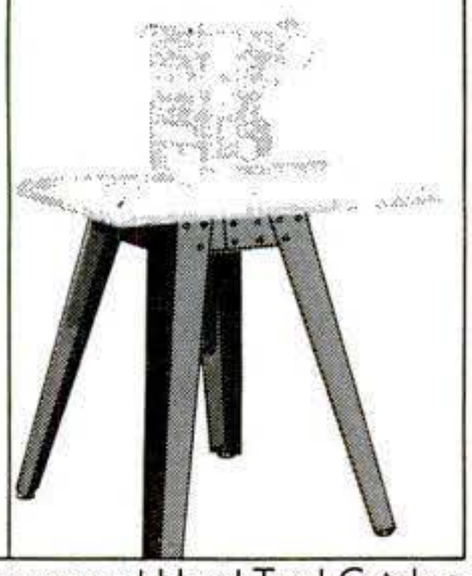

*Based on regular separate prices from 1977 Power and Hand Tool Catalog.

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Filter sentinel
tells you when to clean

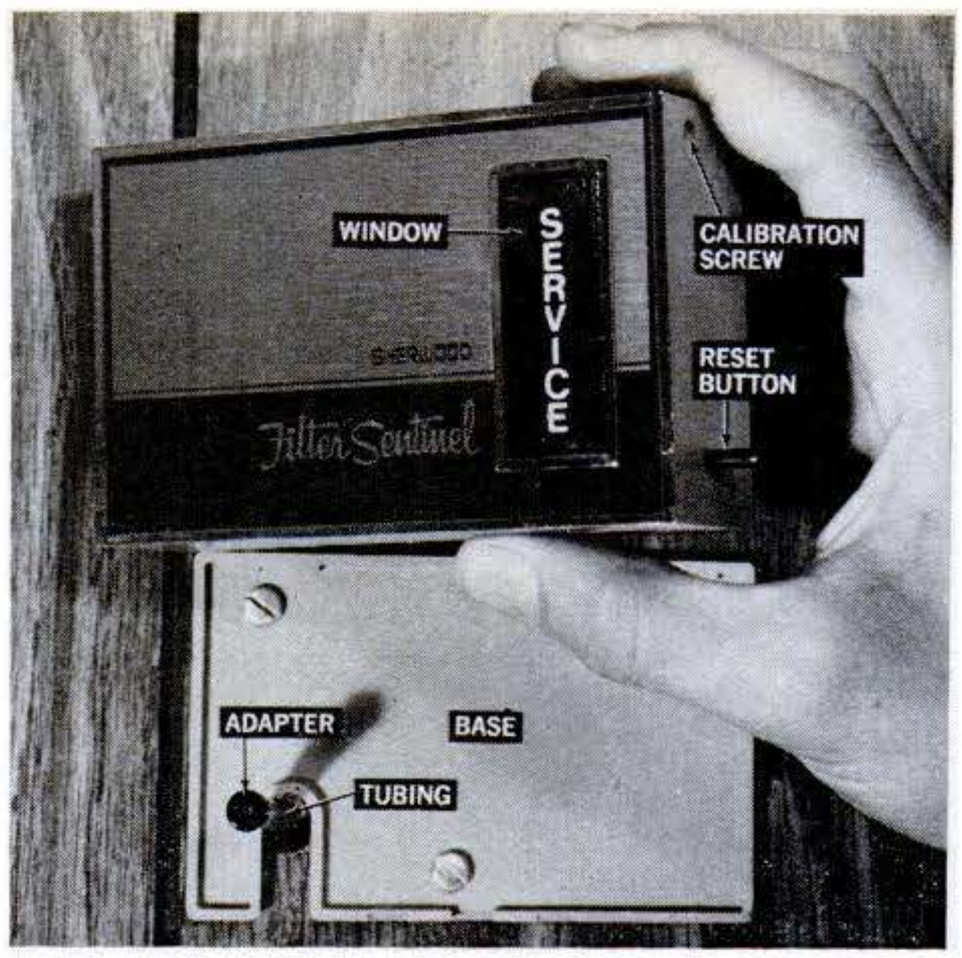
Sherwood's Filter Sentinel helps you maintain furnace efficiency by telling you exactly when it's time to change a clogged air filter. A remote alert is especially helpful if you'd otherwise have to squeeze into a crawl space or cramped attic corner to check the filters. You can install the Sherwood in any air-conditioning system, too—even a window unit.

When dirt clogs a filter, its resistance increases the static pressure differential across the filter. The Sentinel senses this changing differential; when air pressure drops below the efficiency level, a drum behind the filter-indicator's window revolves to reveal the word "service"—time for a filter change.

The Sentinel consists of a sensor probe (small photo) connected by tubing to a control-indicator box. The probe is mounted in the blower compartment or return air duct, downstream from the filters. If your furnace is conveniently located, mount the box directly on it, or up to six feet away, using connecting tubing. For a more distant readout, you can wire the control box—with a low-voltage lamp operating through it—to a remote indicator anywhere in your house.

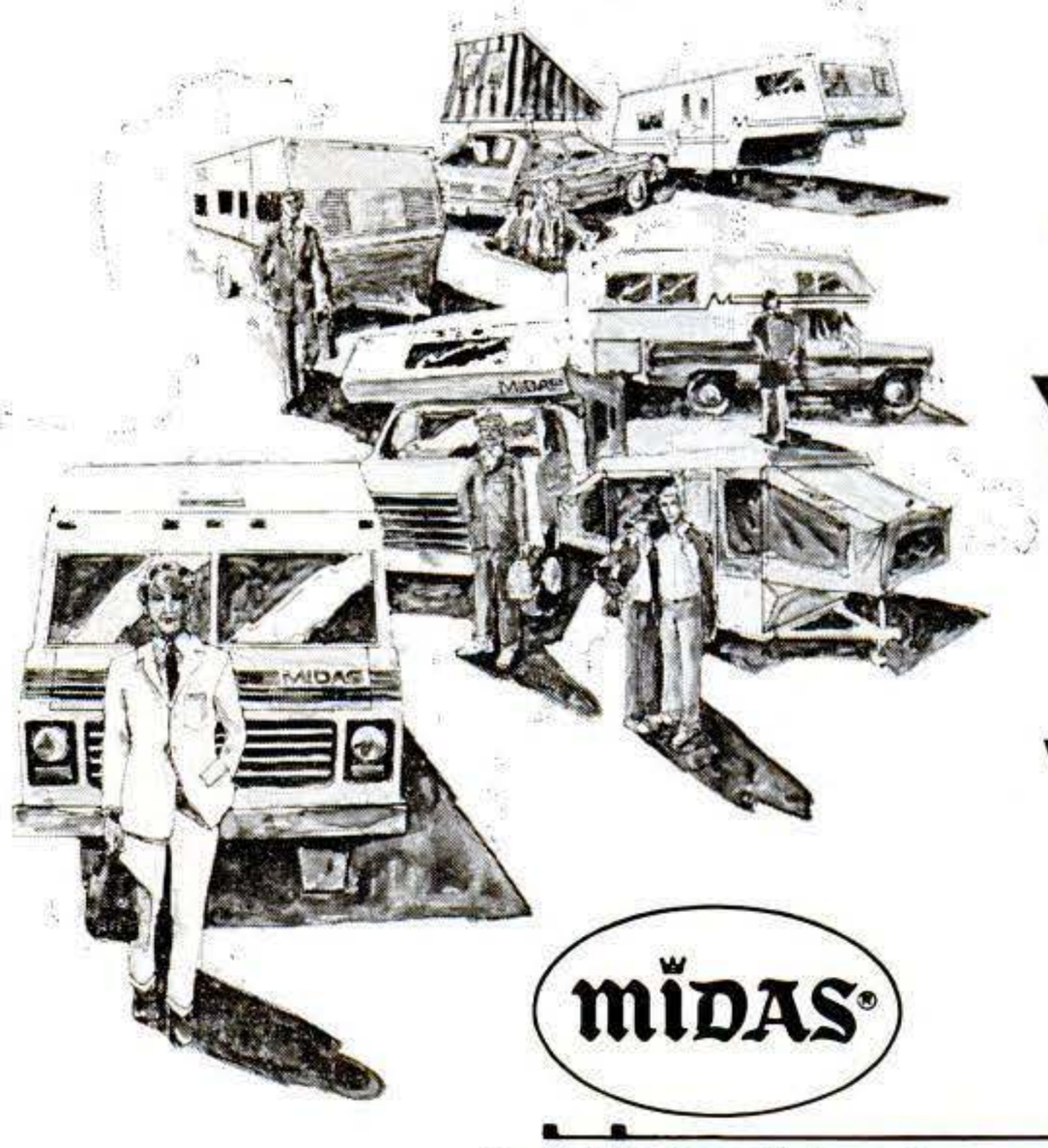
Next step is to calibrate the Sentinel for your system. Put in new filters and tape newspapers over one-third of their area (this simulates minimum efficiency). With all access doors closed tightly, start the blower and press the reset button on the Sentinel. Turn the calibration-adjusting screw clockwise until the word "service" appears in the window. Turn off the blower, remove the newspaper, and press the reset button again. If the window remains blank, the Sentinel is calibrated.

It's available at retail or from Sherwood Products, Box 32583, San Antonio, Tex. 78216.—*Evan Powell*



Control box (right) must be mounted within six feet of sensor probe in return air duct (above) or in blower compartment, or mounted directly on furnace.

MARCH OVER TO MIDAS®...



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For home, garage, shop. Sturdy, wear-resistant yellow safety cord. Swivel hook and switch. U.L. listed.

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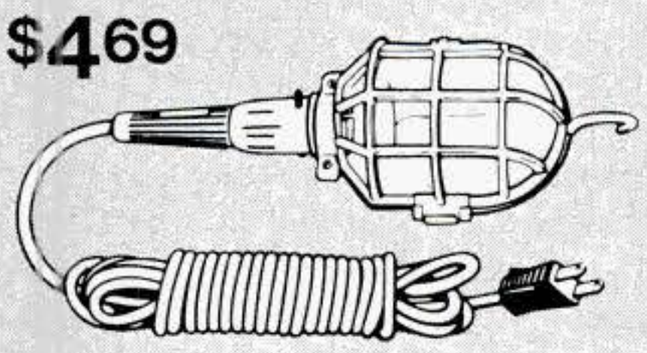

CAROL HEAVY DUTY 25 FOOT EXTENSION CORD

All purpose for outdoor or indoor use. Orange, 3-wire grounded. U.L. listed.

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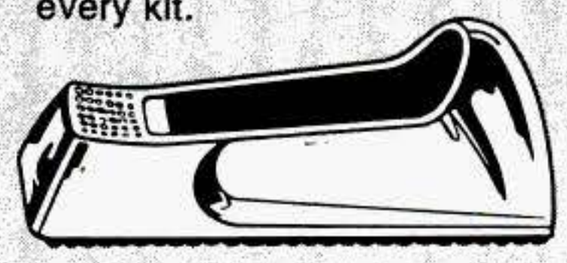

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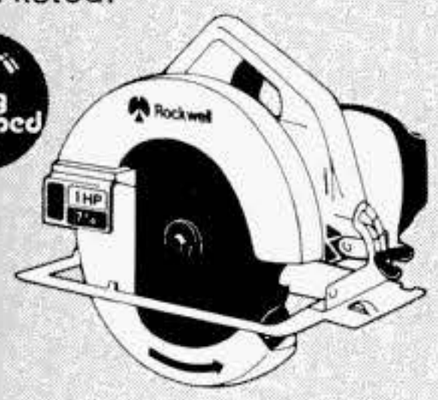

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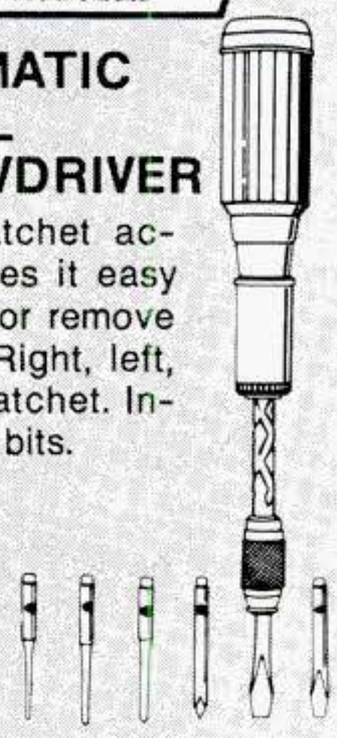

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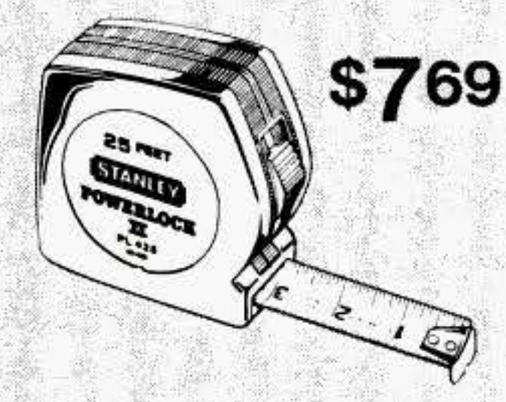

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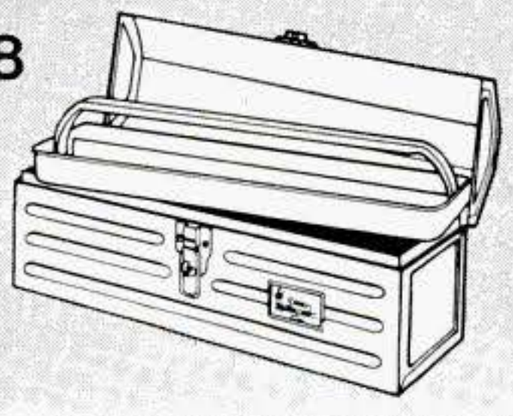

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Pistol grip handle of this 100/140 watt gun makes soldering fast, easy. With 3 soldering tips, wrench, resin-core solder, flux brush, special soldering aid tool. In durable plastic case with guidebook. U.L. listed.

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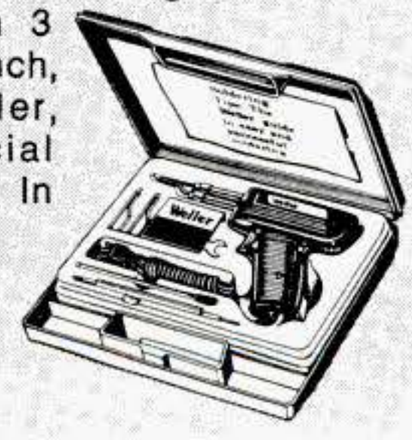

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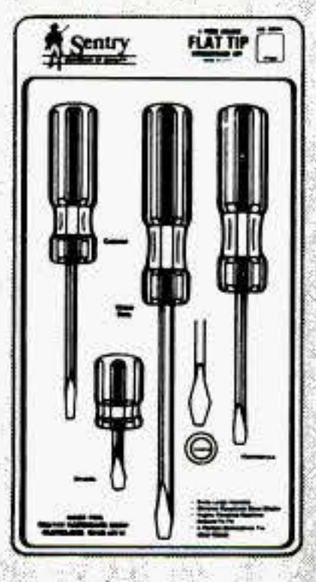
4-Piece deluxe flat tip set. Consists of 3/16 x 4½" cabinet type; ¼ x 1½" stubby; ¼ x 4" mechanics; 5/16 x 6" heavy duty. Chrome vanadium blades. Large plastic handles. Phillips set available at same price. **$3.99** per set.



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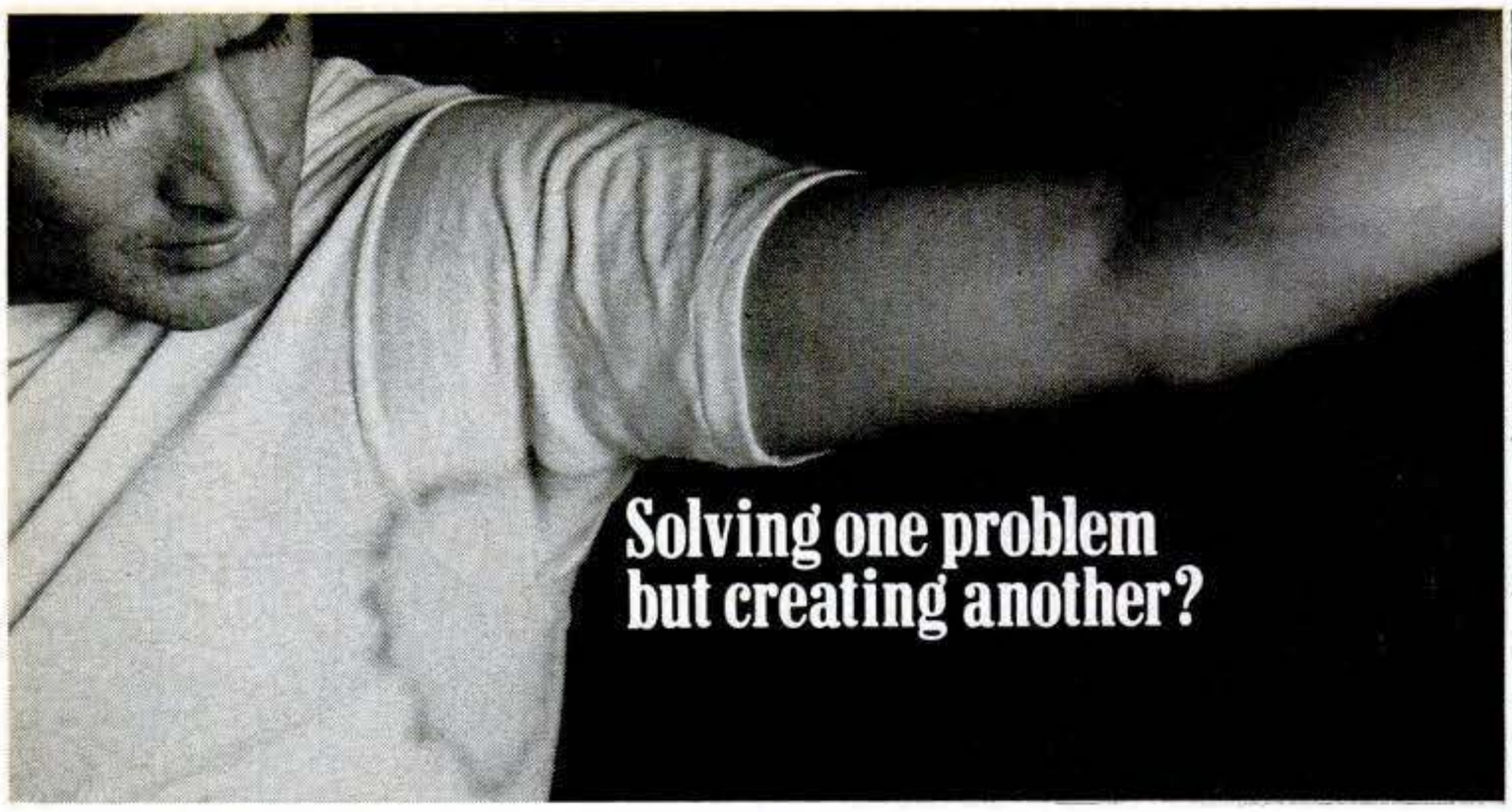

Pushbutton protects against odor and stains.

Mennen Pushbutton Deodorant is a proven anti-stain formula. It protects against odor and embarrassing stains. So button up your underarms—switch to Mennen Pushbutton.

Radio telescope

[*Continued from page 82*]

main reasons NRAO selected the Plains of San Augustin. The area's relatively low latitude permits coverage of about 75 percent of the sky, while its dry climate, high altitude, and ring of protective mountains provide optimum radio reception.

At first, cattle ranchers in the area were skeptical about the new project —but they now accept it.

"We're nonpolluting and we're also quiet," says project manager Jack Lancaster. "We just sit there and listen."

On my visit, cattle grazed peacefully near the tracks, apparently undisturbed by the steadily growing complex. The rural setting makes the VLA appear very impressive—and it's far from complete. At the time of my tour, six of the mammoth antennas were finished. I watched the seventh taking shape inside the big maintenance building, where the antennas are assembled at the rate of one every eight weeks.

Outside, workers were laying miles of rails while, in trenches alongside the tracks, engineers were carefully installing the waveguide—the observatory's electronic communication system. This wideband, low-interference waveguide was developed in the past few years for telephone communications. It consists of pipe of 60mm inside diameter with an inner conducting surface of finely wound copper wire. It was designed to handle 600,000 phone calls at one time; at the VLA it will carry electronic messages from the antennas back to the computers.

I stopped in at the computer rooms where the antennas are monitored and controlled. In this vast nerve center, astronomers will direct the observatory's antennas as they track the sky, while the computers receive and process incoming information. The result: a radio map of the area of sky being observed.

I also toured the assembly rooms where the antennas' complex electronic components are pieced together. But the antennas themselves were the most fascinating stop of all. Dr. Peter Napier, assistant head of electronics for the observatory, took me to the top of one. First, we climbed the long stairway leading past the antenna's triangular base. Then, we trekked up a succession of short stairways and ladders through the maze of heavy tubing that supports the instrument's yoke, elevation drive mechanism, reflector backup structure, and reflector dish.

In the vertex room below the antenna dish, Dr. Napier showed me the electronic racks for the boxes that hold the instrument's eight receiver front ends. There are two for each of the four wavelengths at which the antenna can operate. As in all radio telescopes, the receivers are cryogenically cooled by liquid helium to a temperature of −427° F to minimize internal radio noise.

Next, we climbed a short ladder into the 82-foot-wide main reflector dish. Napier pointed up to the Cassegrain subreflector mounted at the apex of the antenna. The subreflector works much like the secondary mirror in an optical telescope, which bounces light from the primary mirror back to the eyepiece lens. On the VLA antenna, radio waves picked up by the main dish are beamed by the subreflector back down to the feeds in the center of the dish. These then transmit the signals to the receivers below. The feeds for the different wavelengths are arranged on a circle around the main reflector axis, and the subreflector is mounted so it can be rotated to focus on each one separately. Since subreflector rotation is controlled by the main computer, astronomers can quickly and easily change the observing wavelength.

This feed system was one of the major design challenges faced by the VLA engineers, Dr. Napier told me, since it must operate over such a wide frequency range—from 1.3 cm to 21 cm. The present system is based on the offset subreflector and multi-frequency feed system developed by the Jet Propulsion Laboratory for its spacecraft-tracking antennas.

Complex as the antennas are, they are also extremely rugged. They're designed to operate in winds up to 40 mph and can survive gusts of up to 110, even under a heavy coating of ice. And they have to be able to withstand being continually shuttled along the railway.

Under operational conditions, the 27 antennas will be used in four basic configurations involving layouts of 21 kilometers (the full length of the three arms), 6.4 km, 1.9 km, and 0.6 km.

With this level of flexibility, plus the ability to observe over a wide range of frequencies, the VLA will add immensely to our knowledge of the universe. With it, astronomers will be able to peer out almost to the beginning of cosmological time—and perhaps decipher some of the mysteries of the cosmos. PS

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[Continued from page 112]

then drill through both the strip and the sheet-metal floor at the same time. Holes in the furring strips were countersunk so the flat-head bolts would set flush.

To tighten each bolt on the underside of the van, we used a flat washer, lock washer, and nut. After all the nuts were in place and tightened, we sprayed each nut with undercoating from a spray can, which helps prevent rusting, acts as a sealer, and safeguards the nuts from loosening.

To insulate the floor (and, later, the walls) we installed the type of housing insulation that's used on furred masonry walls. It took less than two rolls to do the whole van. By placing the furring strips 16″ apart, you can fit standard-width insulation neatly between them. The insulation cuts easily with scissors. To keep it in place while we put the floor down, we tacked the insulation flanges to the furring strips with a staple gun.

The floor is ½″ interior-grade plywood. It's held to the furring strips with ¾″ number 8 wood screws. Screw holes were again countersunk, so protruding screw heads would not interfere with the tile surfacing.

Because the rear fenderwells stick up inside the van, we had to cut the plywood to fit around them. To get a precise cut, we first made a template from cardboard, then placed that on the plywood, and cut around the template's outline with a jig saw.

To insulate the sides of the van, we just sprayed the sheet-metal sides with 3M's multipurpose glue, then pressed the insulation against it. The glue holds the insulation securely in place.

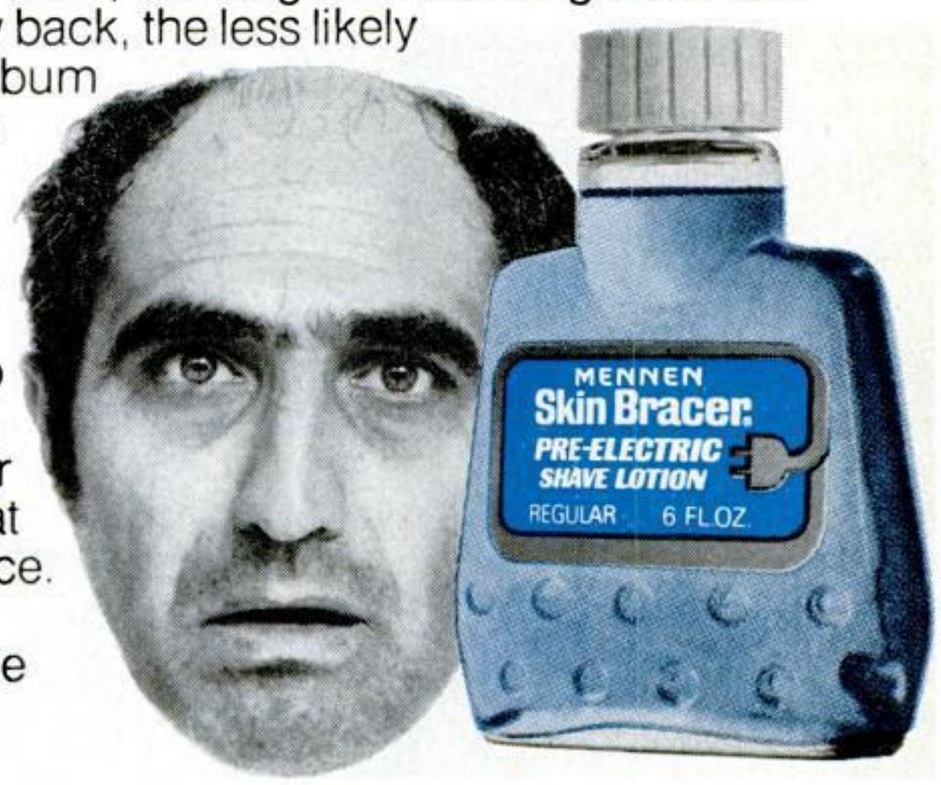
Then we placed furring strips along the sides of the walls running horizontally. We screwed them to the upright metal braces that support the van's sheet-metal sides with 1″ number 8 sheet-metal screws. Holes were countersunk.

For the walls we screwed "door skin" panels to the furring strips with ½″ number 8 wood screws. Door skins—the thin panels used to make doors—bend easily to fit the curvature of the van's walls.

(Our Dodge Maxi-van had a metal brace in the rear on the side that supported the spare tire. Before putting up the walls we cut the brace off with a hacksaw. You'll want to do this, too, if your spare mounts inside—you want all the space you can get in there. We mounted the tire on the rear door with an external tire carrier.)

What every stubble bum should know.

The closer you cut your stubble, the longer it takes to grow back. The longer it takes to grow back, the less likely you will look like a stubble bum before you have to shave again. Which brings us to Mennen Skin Bracer® Pre-Electric Shave Lotion. It tightens your face, conditions your stubble so you can shave extra close. It even helps lubricate your razor head, and it's got that clean Skin Bracer fragrance. Congratulations. You are soon to join the ranks of the ex-stubble bum.



Furnishing your home

Next, we began building cabinets and installing the components. We mounted the refrigerator, furnace, cook stove, and sink in a big cabinet on one side of the van. To hold all cabinets in place we screwed them to the floor and to the furring strips in the wall. A few pointers here:

- Use ½″ interior plywood to make all cabinets, so that they'll be plenty sturdy.
- Remember that the backs of the cabinets will not be straight, but must have a curvature to fit the van's sloping sides. To make precise cuts, work from a cardboard template.
- Follow installation instructions that come with furnace, cook stove, refrigerator, etc. Pay particular attention to clearances. If instructions say, for example, that the furnace must be four inches from the nearest wall, make sure that it is.

For the bed we built a permanent platform across the top of the driver-passenger area. Two shelves rest atop the platform. When it's bed-time, we pull the two shelves out toward the rear of the van and we have a bed of queen-size dimensions. The platform and shelves rest on 6′ wooden rails—one on each side of the van.

The rails are 1″-by-3″ boards with a piece of angle iron beneath the bottom of each to lend strength. They are held secure by metal screws that run through the boards and angle iron and into the sheet-metal braces that once formed the edge of the original roof.

Electricity for the interior is provided by two large-capacity 12-volt car batteries hooked up in parallel to the engine's alternator. An auxiliary battery relay (available at Chevy dealers) is hooked in between the alternator and batteries.

The floor is self-adhering vinyl tile. All cabinets were covered with thin mahogany panelling, which was attached by tiny ¾″ brads. Upholstery is blue velour fabric, cut to fit with scissors, and held on with 3M's multipurpose glue. For protection against theft, a sophisticated burglar alarm was installed by Babaco Alarm Systems.

How do I like my new van? Just fine. It's as much fun to use as it was to build. PS

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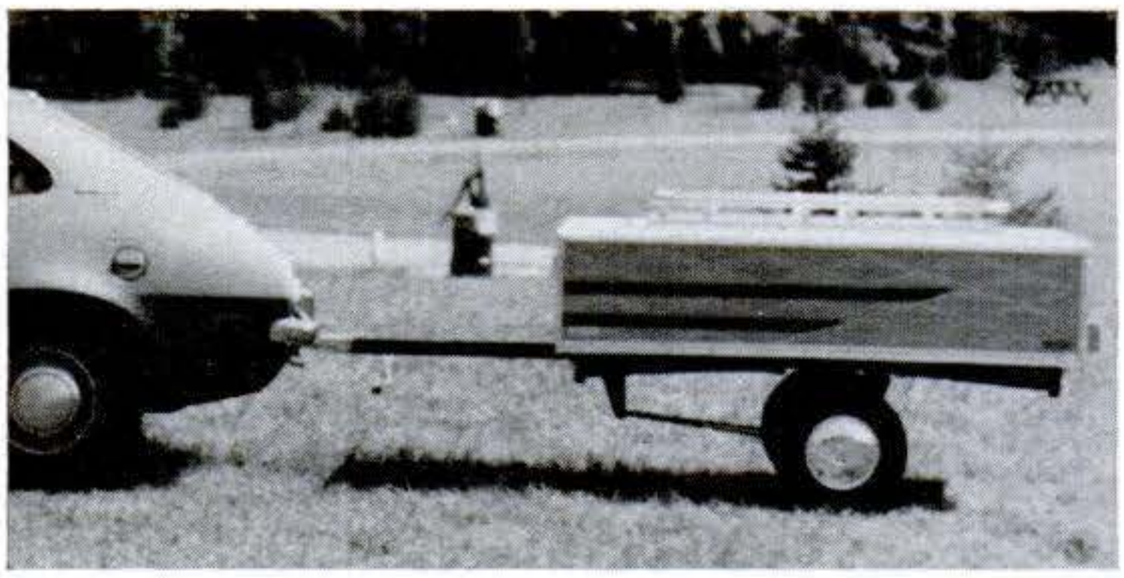
[Continued from page 108]



Tiny camper is small enough to be pulled by a motorcycle, and perfect for small cars. It unfolds into a tent on a platform that sleeps four. Trailer weighs only 230 lb. Made by Time Out. Price: $945.

for carrying campers. The Toyota Chinook, for example, gets 28 mpg on the highway, and the rig's excellent design doesn't surrender much in the way of amenities.

The Toyota Chinook is a small chassis mount, so you have access to the camper from the driver's compartment—a feature that makes it different from slide-in campers. Because the camper is built low to eliminate wind drag, it has a pop-top roof. With the top extended, you get over six feet of head room.

These no-frill campers give you a good alternative to the army of posh motor homes and trailers that bear little resemblance to camping vehicles. PS

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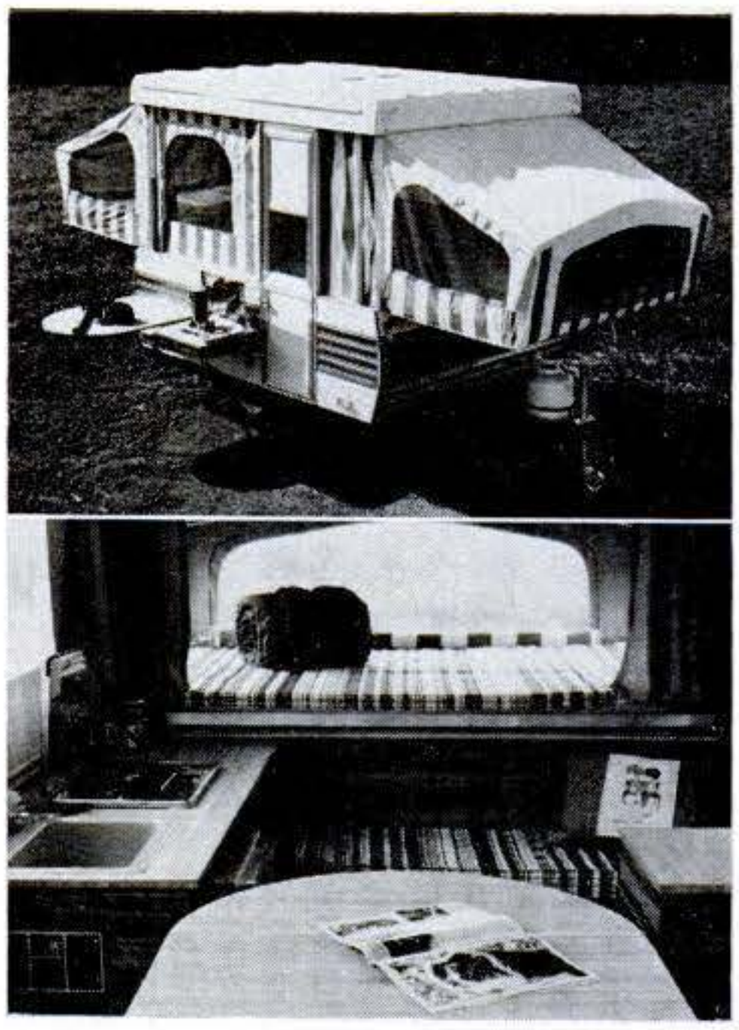

Compact and lightweight Steury M700C camping trailer has galley that you can use in or outside the rig. Interior is roomy enough to sleep seven. It weighs 1130 pounds and has hitch weight of 135 pounds. Price is $1945.

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[Continued from page 114]

mortgage on any home, and, with proper care, should last upwards of 50 years."

How can thin parquet wear so well? Manufacturers say that walking on wood, rather than wearing it away, really tightens the grain, giving the floor a rich and mellow patina as it ages.

When you compare this with carpet, it looks good. The U.S. Department of Agriculture says the "total annual cost" (prorating installation and maintenance over a 50-year life) of any hardwood floor is 6.67 cents a square foot. Composition tile, which lasts about 18 years, cost 11.8 cents, while wall-to-wall carpeting, which must be replaced in about eight years, costs 16 cents. In fact, Brady Hendron of Harris Manufacturing told me: "All across the nation, wall-to-wall carpeting installed in the early 60's is wearing out and being replaced with wood."

Wood floors were once the staple flooring in American homes. Carpeting caught on, partly because it was so easy to maintain compared with wood. But in the old days, people were actually maintaining the wood's surface finish, which scratched and chipped easily, demanding a frequent down-on-the-knees wax job. Today's penetrating sealers are different: The finish is *in* the wood, not *on* it. You wax sparingly—no more than twice a year—and buff whenever the floor looks dull. With this kind of care, says John Sakosits of Hoboken Flooring in East Rutherford, N.J., "the finish should last as long as the floor."

By now, the skeptics among you may be muttering: What does this wonder floor *look* like? Well, the editors of POPULAR SCIENCE have been flocking into my office, lured by the sight of the gleaming samples I've collected. And I visited a couple of dealers to see if the stuff is as good-looking on the floor as it is on my office shelves. My conclusion: The pictures we've shown you are quite accurate. If you like wood, these floors are superb—rich-looking, warm, and glowing.

Which floor to choose?

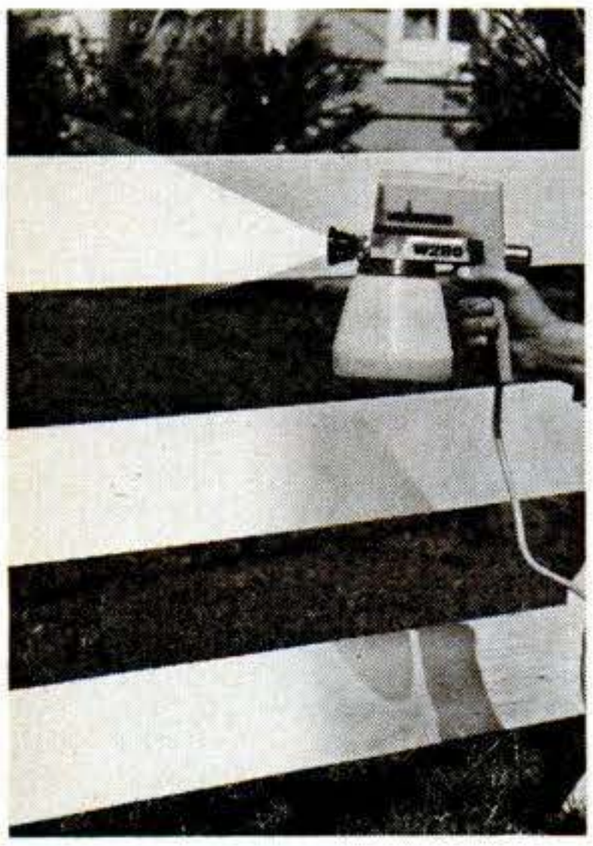
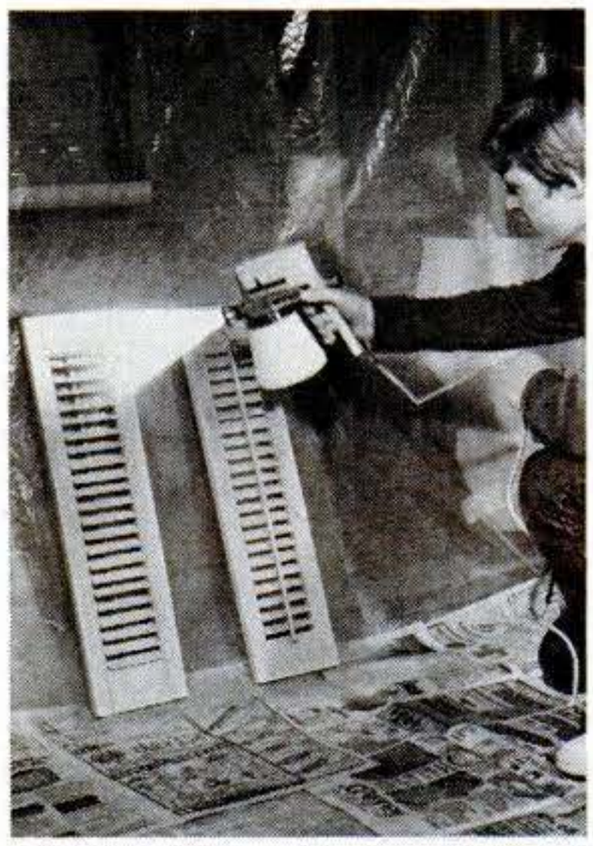
Two things determine what kind of floor you can install: The money you're willing to pay, and the time and care you're willing to spend on installation.

If you don't have the patience or skill to fool around with mastic, both Wood Mosaic and Tibbals (see chart) offer adhesive-backed parquet. You can install this parquet as easily as you'd lay adhesive-backed linoleum tile. You do pay extra, though, for this convenience, and it's not advisable to install these floors below grade (in a basement).

Mastic can be cheaper

You can also glue parquet down with mastic. This takes more time and demands more skill, but in many cases, it will cost you less. Harris' DuraBlok, at about 80 cents a square foot, Bruce's Cumberland Oak, at about $1 a square foot, and Tibbal's Hartco Wood Floor-Tile at about $1.29 a square foot, will all give you a handsome, block-pattern floor. More elaborate prefinished patterns can run from $2.50 for Sykes' Herringbone to $3.75 for Memphis' Monticello.

A glance at the chart shows that you can also get unfinished parquet. John Stern of Wood Mosaic

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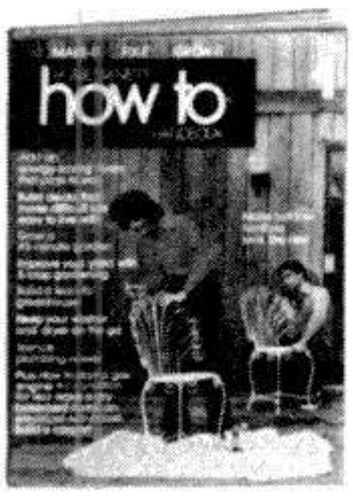
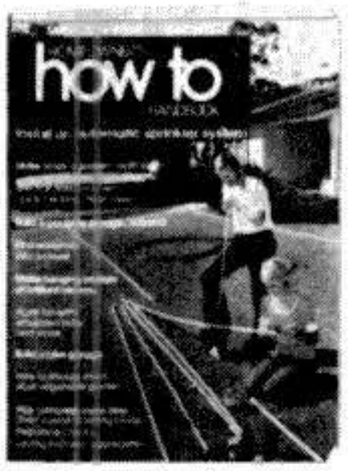


Spring HOW TO:

Here's how to shake off the ravages of winter and spruce up the home for the beautiful months that follow. HOW TO shows you how easy it is to make outdoor furniture look new again; how to add an outdoor deck to your home; improve your gardening skills with tips on a more efficient method of planting; how to build a carport that will provide better protection for your vehicle next time around. In addition, you'll find instruction in how to add an energy-saving utility room to the house; advice on how to keep your washer and dryer on the go; tips on how to silence plumbing noises; plus much more. With a helper like HOW TO on the job, there's no telling how much hard-earned money you'll be able to save next time Spring cleanup rolls around!



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Fall HOW TO:

When leaves begin to fall, the thoughts of the concerned homeowner turn toward the cold winter months ahead. And, when it comes to preparing for Old Man Winter, HOW TO is loaded with the kind of project ideas that will make every Fall weekend a do-it-yourselfer's delight. Here is instruction in how to tune your water heater for efficiency and reliability; how to install a fireplace or stove in your home; how to construct a pit greenhouse for efficient year-round gardening. In addition, Fall HOW TO provides expert advice on how to convert your basement into usable living space; tips on how to open stopped drains like a professional; how to install ceramic tile; plus much more. With HOW TO's help, you'll be sitting snug next time Jack Frost knocks at your door!

Winter HOW TO:

When the weather outdoors keeps you indoors, you'll find plenty of time for projects that will add to the interior beauty and overall value of your home. In the information-packed pages of HOW TO you'll discover numerous attractive decorating ideas for the home, including instruction in how to make that attic bedroom a truly attractive part of the house. In addition, you'll learn how today's shades and blinds make it possible to have well-dressed windows for less; how easy it is to make your own handsome, low-cost picture frames; how to prevent the pipes in your home from freezing up; plus tips on how to select and use a snowthrower; how to install an efficient central vacuum system, and much more. With Winter HOW TO, you can give your home a whole new look by the time Spring rolls around!

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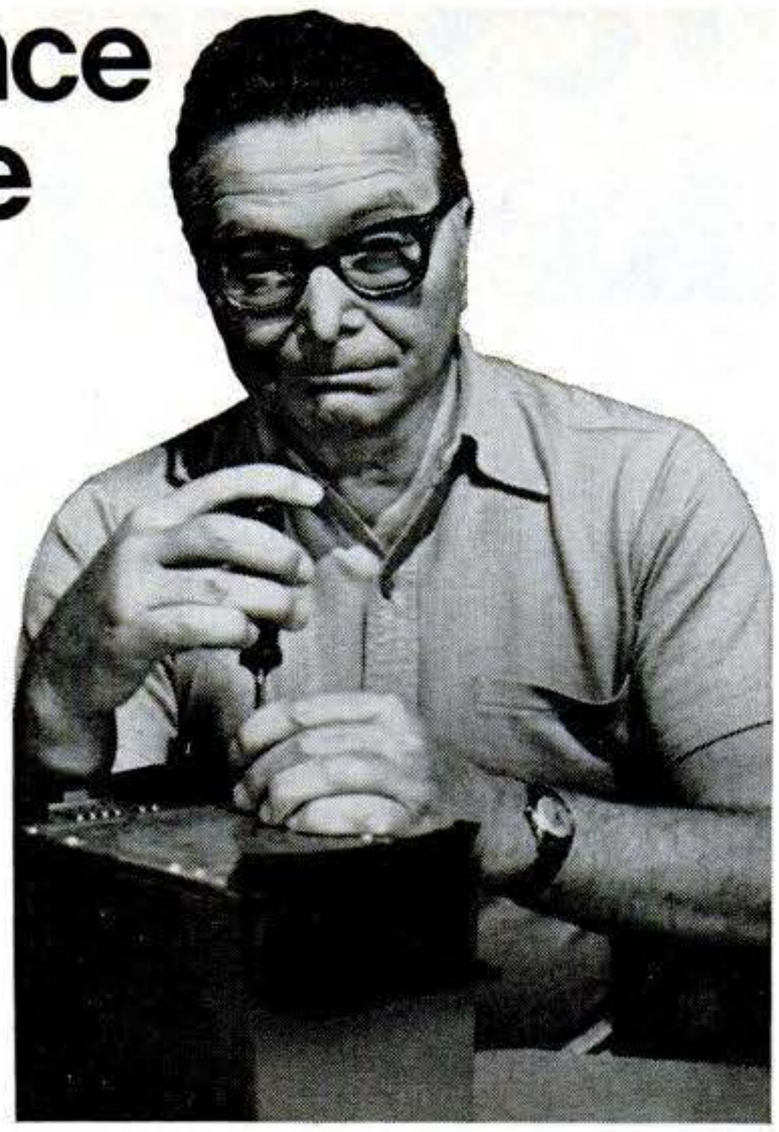
HENRY MORGAN SAYS:

"Good appliance repairmen are scarcer than doctors who make house calls."



Did you know that there are over a billion appliances in use in the United States today? And three repairmen. At least that's the way it seems when one of mine goes on the blink. With more than two dozen electrical gadgets in my house going snap, crackle and pop, I finally got tired of trying to locate a guy with enough ambition to take my money and I decided to learn how to make the repairs myself.

When a well-aged comic like me decides to go back to school, you can bet the family jewels it won't be back at P.S. 93. I'm going to learn at home, or not at all. So I sent away for NRI's home study course in Appliance Repair . . . and I took the course.

With a mechanical aptitude slightly below that of King Kong, I needed a course that started at the beginning and didn't move ahead too fast. Well, NRI did just that. They started with electricity—what it is and what it does—and went from there. You proceed at your own rate of speed. Whip through it if you want to, or take your time. What counts is the fact that you learn, in a way that it sticks with you.

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NRI's no fly-by-night outfit. They've been training men for more than sixty years . . . and they've had over a million students. It's the oldest and largest home study school in the field of electronics and electricity, so they know it better than anyone else around.

The NRI course is really easy to understand . . . with lots of pictures to show you what they're talking about. They even send you a professional appliance tester at no extra cost.

With the tester and a few basic tools you probably have already, you're ready to service most electrical appliances. After a few months, you'll be fixing your own appliances like I do, or you can start earning spare time money fixing them for your friends and neighbors. Before you know it, you can have your own full-time business and be independent.

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Parquet floors

[*Continued*]

says: "With unfinished floors, you can choose your own color and finish—whether penetrating sealer, urethane, or even a combination." But, he cautions: "The many sandings necessary fill the house with sawdust; it's like living in a sandstorm."

Professional finishing

If you don't mind the mess and want to install an unfinished floor, don't finish it yourself. Manufacturers, dealers, and handymen alike insist this is a job for a professional. If you've ever refinished a floor, you know how hard it is to keep the heavy industrial sanders from gouging out holes. The danger is even greater with new, raw wood—especially when that wood is small pieces of parquet set at angles to each other. "The finishing is only about one-fourth the cost of the whole installation job," says Arnold Kronberg of Designed Wood Flooring (New York City), so you'll still save by laying the floor yourself.

There is one final category: Unfinished paper-faced parquet. This has no backing but instead has paper glued on top to hold the many separate pieces together. Most manufacturers were reluctant to recommend paper-faced patterns for the amateur installer, so they are not listed in our chart. But, if you want a distinctive (and expensive) floor, and have full confidence in your skill, most dealers will probably give you the advice you need to lay a custom floor.

Ask the dealer

In fact, it's a good idea to sit down with the dealer to discuss your experience, the condition of your subfloor, and the traffic the new floor will get, before making your final selection.

Dealer John Sakosits always suggests to his customers: "Pick a pattern that will give you at least 10 repeats across the width of the room. And remember, the more repeats you have, the larger the room will look. But if the pattern is too small, it may make a large room look busy."

Depending on the product you choose, and the quantity you buy, your dealer may or may not be willing to break up a carton for you. But, if you have left-over parquet, you can use it to cover an old trunk, refurbish a tired table top, or even panel an accent wall. PS

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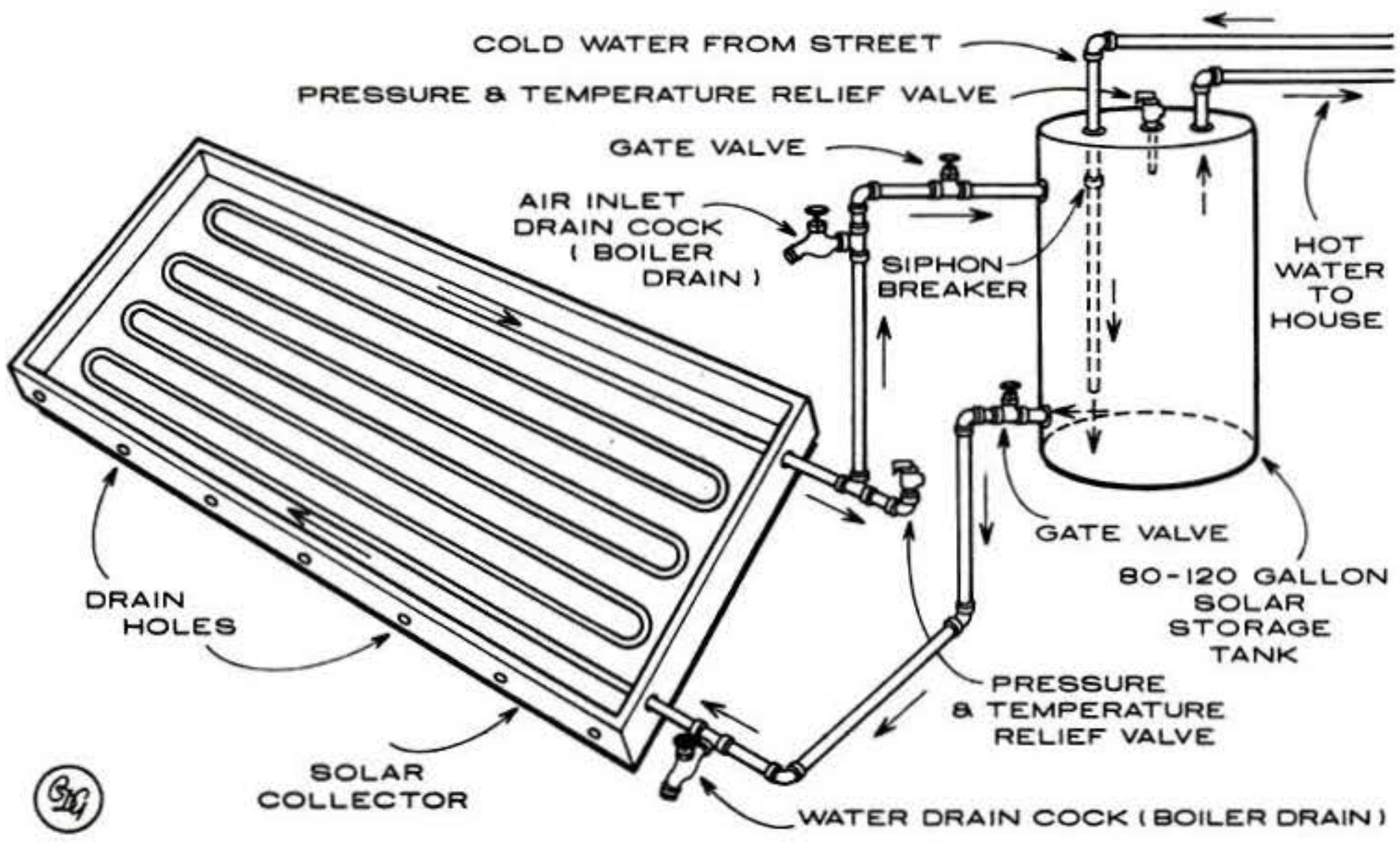
SHOP TALK

By RICHARD STEPLER



Solar how-to

What's a solar water-heating system? How much will it save on your utility bill? And how do you build and install one yourself?

You'll find the answers in a dandy 25-page booklet published by Florida's Environmental Information Center. "Build Your Own Solar Water Heater" includes step-by-step instructions for assembling two types of systems: thermosiphen, which makes use of natural circulation by locating the collector below the storage tank (see drawing above); and forced circulation, which requires a pump to move water from the tank to the collector. Exceptionally well illustrated, the booklet provides a complete list of materials needed, plus cost estimates. Even if you ultimately decide to buy a commercial system, you'll be a lot wiser—and a smarter shopper—by reading this booklet first.

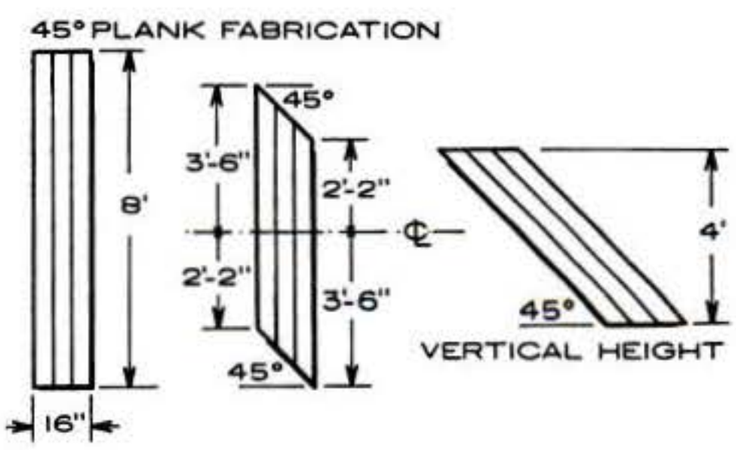
The Environmental Information Center (935 Orange Ave., Winter Park, Fla. 32789) asks a minimum donation of $2.50 to cover the cost of the booklet.

Another slant

If you were inspired by last month's article, "A New Slant for Wall Paneling," you now have an alternative way to get this striking decorative effect: Marlite is offering instructions for installing its "mini-paneling" at either a 45° or 60° angle. (The 45° effect is shown in the photo and drawing at right.) You've got three design options with the Marlite system: bookmatch, regular stack (shown in photo), and random stack.

Marlite offers its 16" by 8' planks in textured and smooth wood-grain patterns, as well as in solid accent colors. Alternating several different colors in diagonal stripes would produce an even more striking accent wall.

For copies of the 45° and 60° diagonal plank instructions, plus a catalog of Marlite's interior products, write Marlite, Div. of Masonite Corp., Dover, Ohio 44622.



Save your trees

Will a bolt of lightning damage or destroy one of your prized shade trees this summer? Accoring to John W. Joy, vice-president of Davey Tree Expert Co., "Trees are more likely targets for lightning when growing alone, in the open, at the peak of a hill, or along a stream or lake where their roots are constantly in moist soil." Also, he adds, "Trees that extend above the general height of surrounding objects are definitely more vulnerable."

Are some trees more likely to be struck than others? "Because of bark structure, water content, and characteristic height," says Joy, "oak, locust, elm, hickory, tulip, poplar, spruce, and pine are especially susceptible to lightning damage."

While you can't prevent a tree from being struck by lightning, you can equip it so that the charge will be dissipated harmlessly into the soil. Attach a copper cable to the highest parts of the tree running down the trunk to the ground in as nearly a straight line as possible (see photo). Run branch conductors from main limbs in the upper part of the tree and attach them to the main conductor. Ground cables, buried in narrow trenches, are attached to the main conductor and extend from the base of the tree like the spokes of a wheel. Finally, attach a copper rod to each ground cable and drive each into the ground at the end of each trench. These distribute the current beyond and below the roots, which are as sensitive to injury as the top of the tree.

While the complexity of a lightning protection system will probably require a professional installation, there's a lot *you* can do to insure a long, healthy life for your trees. The "Davey Guide to Tree Beauty and Tree Care" shows you how to spot tree problems, how to recognize insects and diseases. Planting, feeding, and moving tips are included, too. For a copy of the 36-page booklet, send 50¢ to Davey Tree Expert Co., 177 South Water Street, Kent, Ohio 44240. PS

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Available at most larger Sears, Roebuck and Co. stores, and in the catalog.

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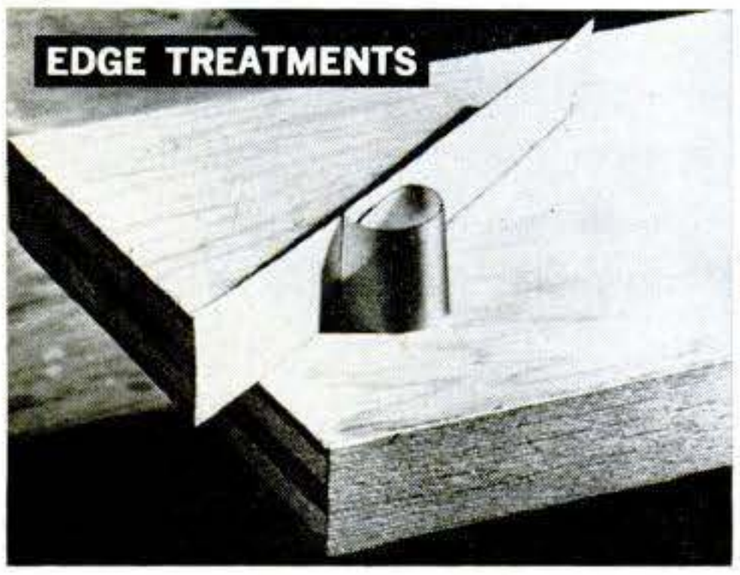
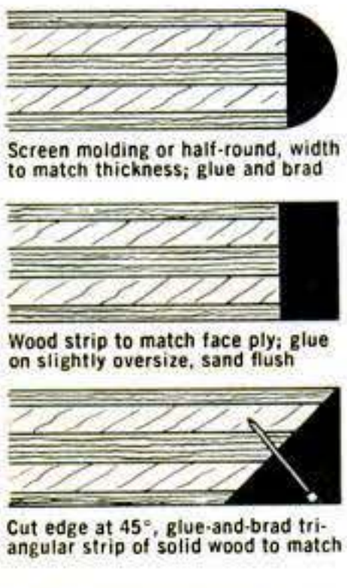
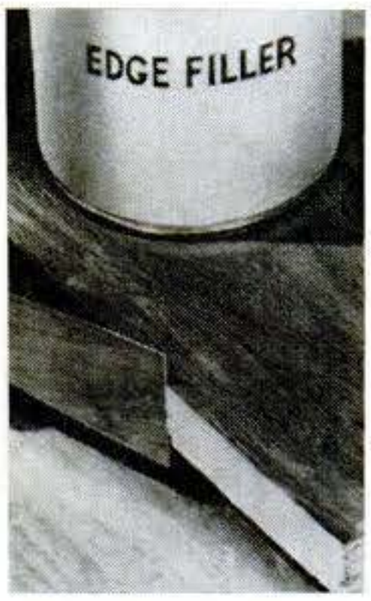
[Continued from page 126]







Mask exposed plies with peel-and-stick veneer strips to match face (top photo) or solid wood strips (sections, left). For painting, fill edge with wood putty.

ing) stain. It'll penetrate the surface to provide protection, yet leave desirable grain and texture exposed. If you'd prefer to reveal only the texture, use an opaque or heavy-bodied oil stain.

To work the stain into the wood, use a brush. And remember to first seal edges with a liberal application of a good water-repellent preservative such as Cuprinol or Woodlife.

If you'd rather paint your project, select an acrylic-latex exterior house paint with companion non-staining primer. Brush the primer on the panel and all exposed edges. On MDO plywood, oil-alkyd paint and primer can be used, instead, if you prefer a harder finish.

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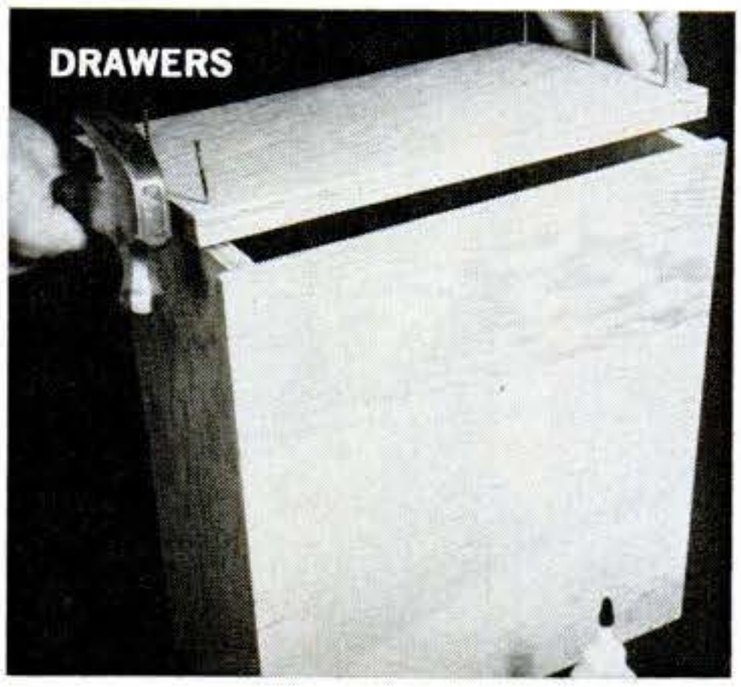
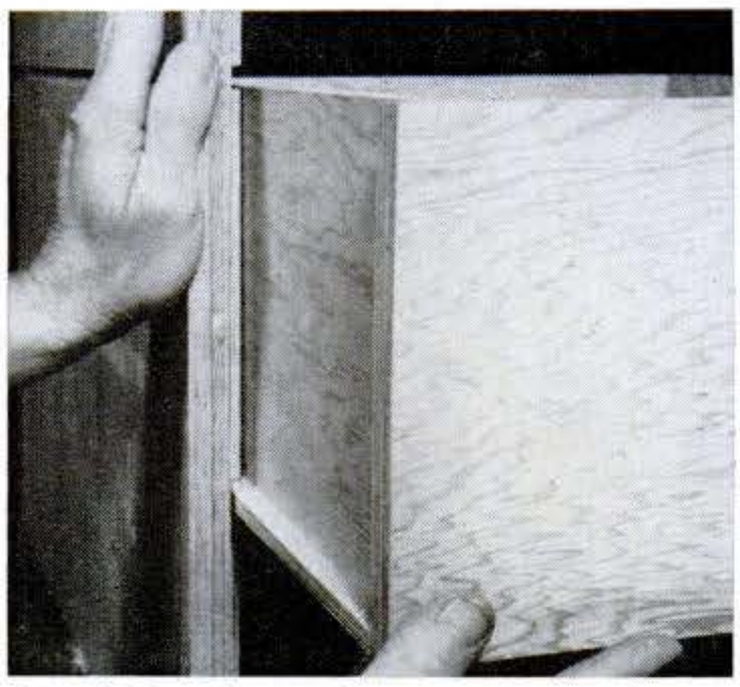
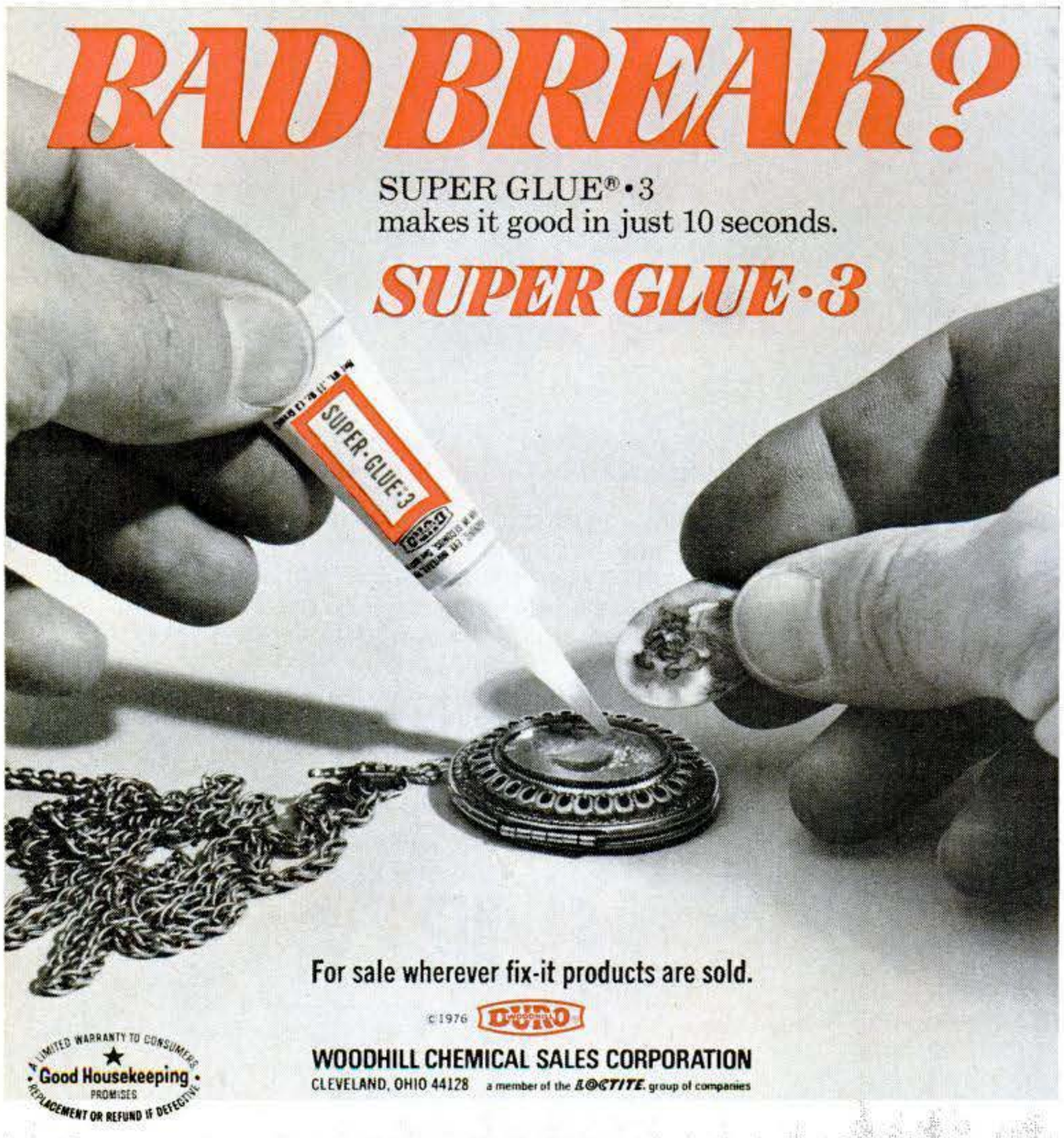


Simple drawer is made with hand tools. Note ⅜"-ply bottom extends ⅜" beyond ½"-ply sides; ¾"-ply front does, too, is applied with glue and nails.



Carefully dimensioned drawer will slip into slots formed by gluing panels of ⅜" plywood (slightly wider than drawer sides) to inner faces of cabinet sides.



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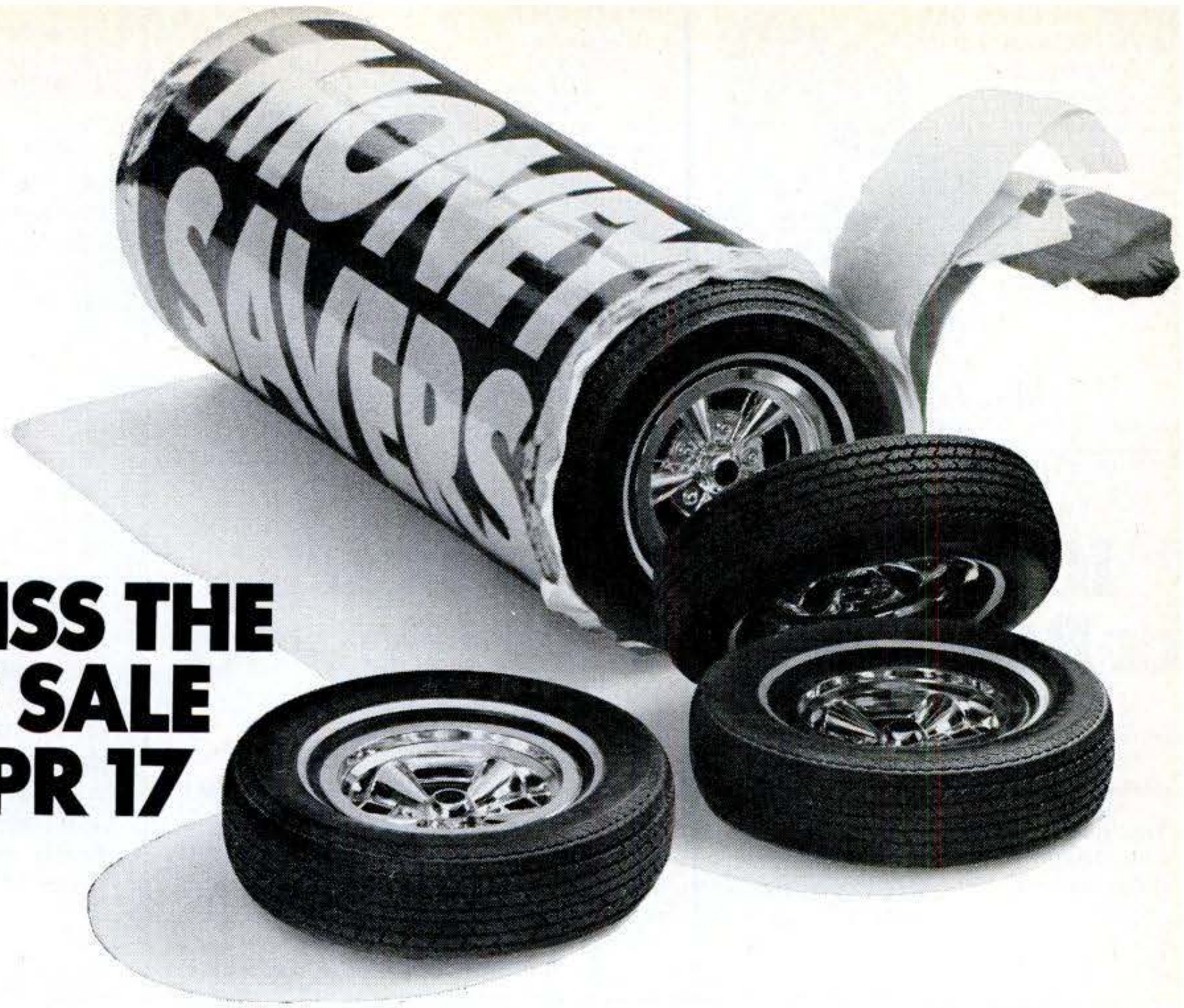

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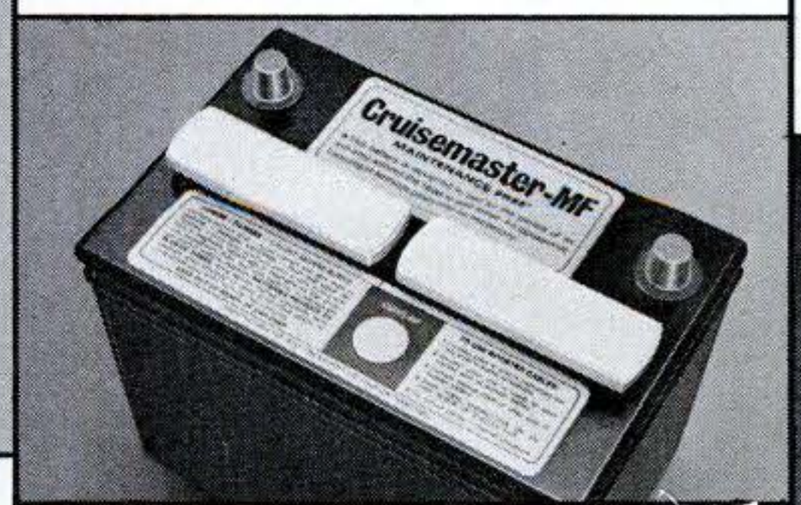

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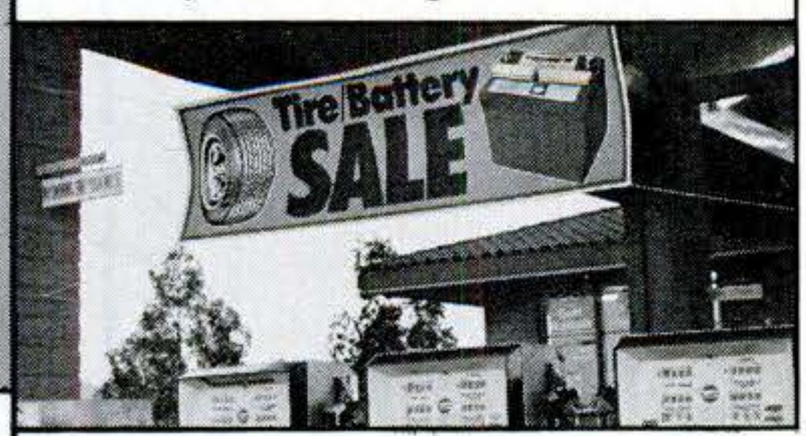

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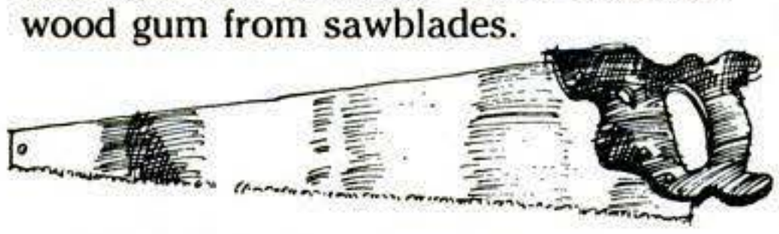

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How to work with plywood

[*Continued*]

Whether you select paint, stain or sealer for interior projects, touch-sand the plywood to smooth any filler or spackle applied to surface cracks or edge voids. Clean off all dust and spots of glue and oil, and use sealer or shellac to touch up knots, pitch streaks, sap pits.

For a flat-painted surface, use either oil- or water-base paint. Both can be easily brushed, rolled or sprayed on. Oil-base paints, which usually offer the best washability and durability, are sometimes self-priming. Water-base paints (usually latex) dry quickly; prime as suggested on the label of your top-coat paint. For a shinier finish, use a gloss or semigloss enamel.

A combination stain and non-penetrating sealer can be applied with brush or spray. After drying and light sanding, a coat of clear finish can be added for luster and durability, especially outdoors.

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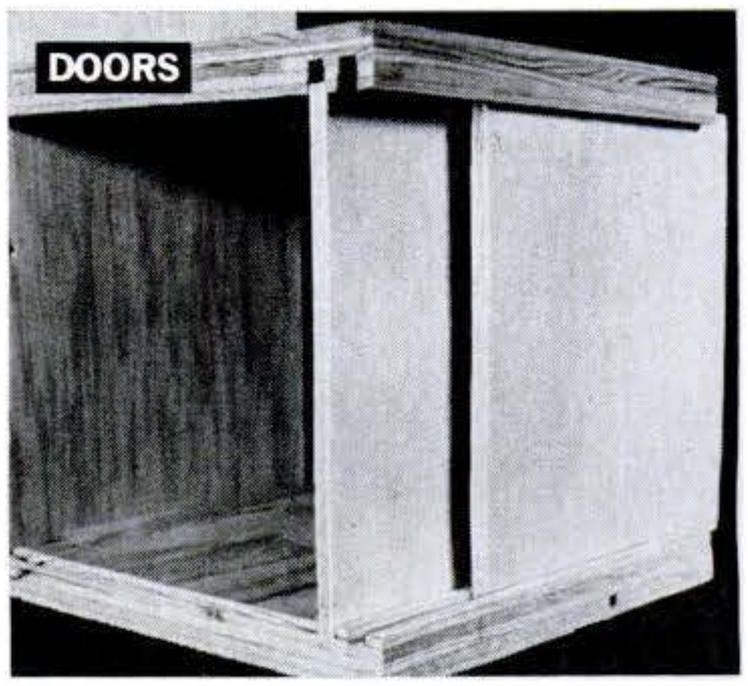
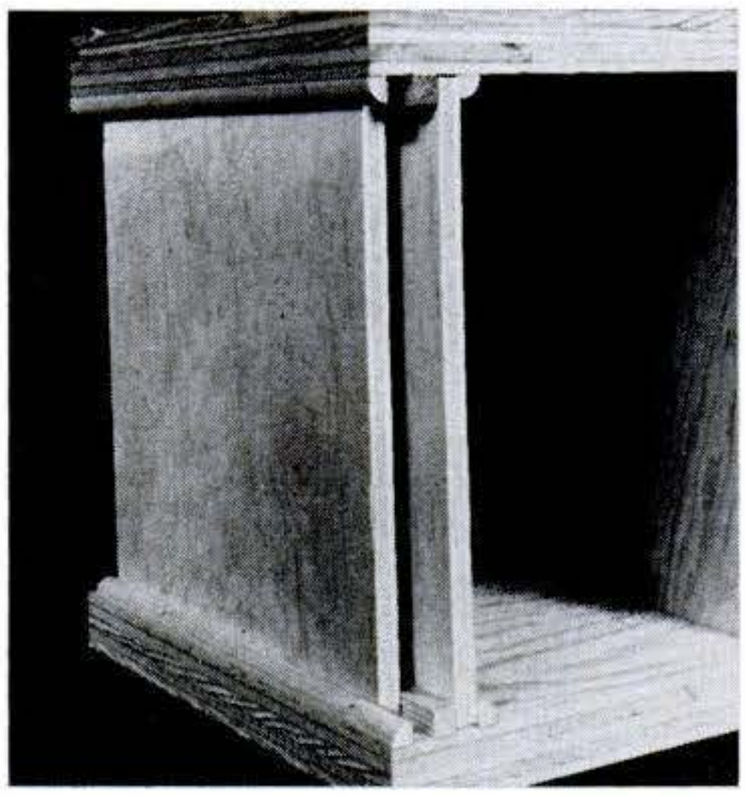


Plywood is ideal for sliding doors. To make panels removable, plow top pair of grooves 3/8" deep, bottom pair 3/16". Push panels fully into top grooves, drop.



No grooving tools? Install commercial door track or make your own with strips of 1/4" quarter-round front and back, 1/4" square between. Wax grooves.

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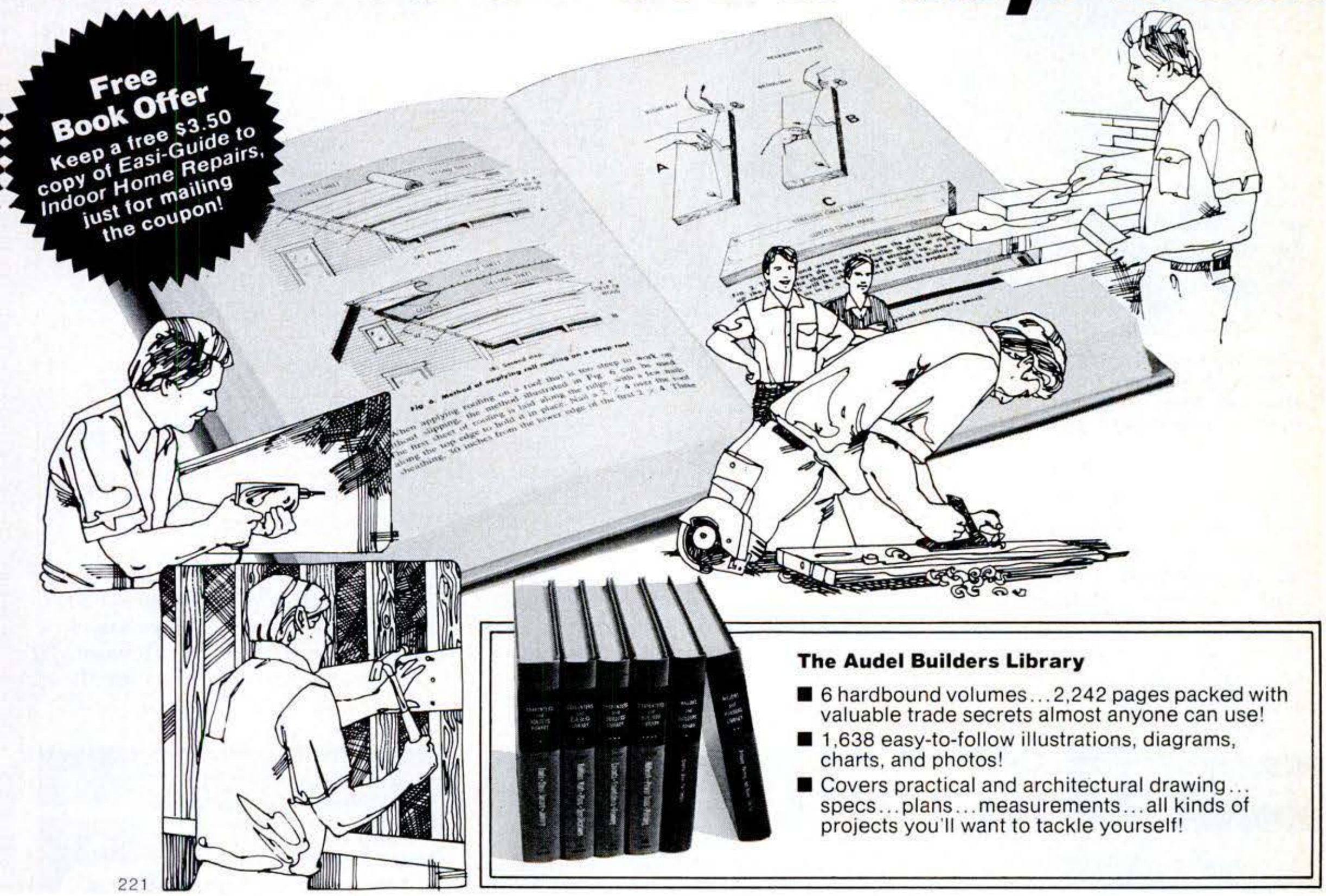

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[*Continued*]

Textured and striated panels are best stained (or painted) by brush. Note how stain has been thoroughly worked into grooves before coating face between.

INTERIOR APPLICATIONS

TYPE OF FINISH*		RECOMMENDED FOR	APPLICATIONS
PAINT	Oil—flat paint, semi-gloss or gloss enamel	Medium density overlaid (MDO), regular plywood, striated, embossed	Apply over primer, or may be self-priming
	Latex emulsion	Regular and textured plywood, MDO	Apply with oil or stain-resistant primer
	For textured effects	Regular plywood, MDO, Texture 1-11	Use oil base or stain-resistant primer
STAINS, SEALERS		Regular plywood, textured	Apply stains with companion sealer or over sealer separately applied. Follow with satin varnish or lacquer for increased durability. Where sealer alone is desired, use two coats

*Use only lead-free finishes

EXTERIOR APPLICATIONS

TYPE OF FINISH		RECOMMENDED FOR	APPLICATION
PAINT	Acrylic latex	MDO, striated, or regular plywood panel or lap siding. Also 303 textured plywood	Apply recommended nonstaining primer plus two finish coats
	Oil—alkyd	Medium Density Overlaid	Apply with zinc-free primer, using two or three coats (including primer)
STAIN	Semitransparent or penetrating stain	Unsanded plywood (303 textured plywood)	One or two-coat systems as recommended by the manufacturer
	Opaque or highly pigmented stain	Unsanded plywood (303 textured plywood)	One or two-coat systems as recommended by the manufacturer

Or, for a lighter effect, plywood can first be whitened with a pigmented resin sealer or interior white undercoat, mixed one-to-one with thinner. Before it dries enough to be tacky, the sealer is wiped off the surface, leaving pigment only in the pores. Then a clear resin sealer is applied. Color is added with a tinted undercoat, thin enamel, pigmented resin sealer or light stain that's applied and wiped to the desired color depth. The last step is application of satin varnish or brushing lacquer.

For a simple natural look on either sanded or textured plywood, just use two coats of a clear sealer, to protect against soiling. However, this effect is rarely suitable for the "wild grain" of fir plywood. PS

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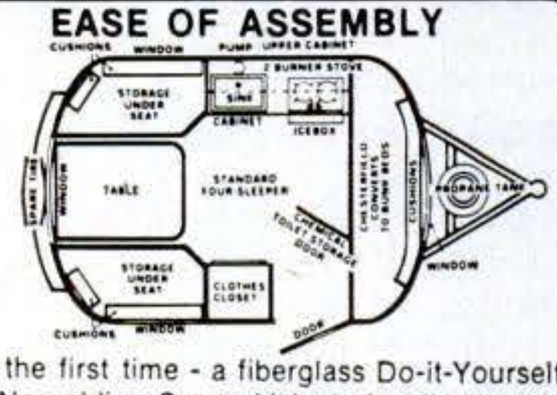

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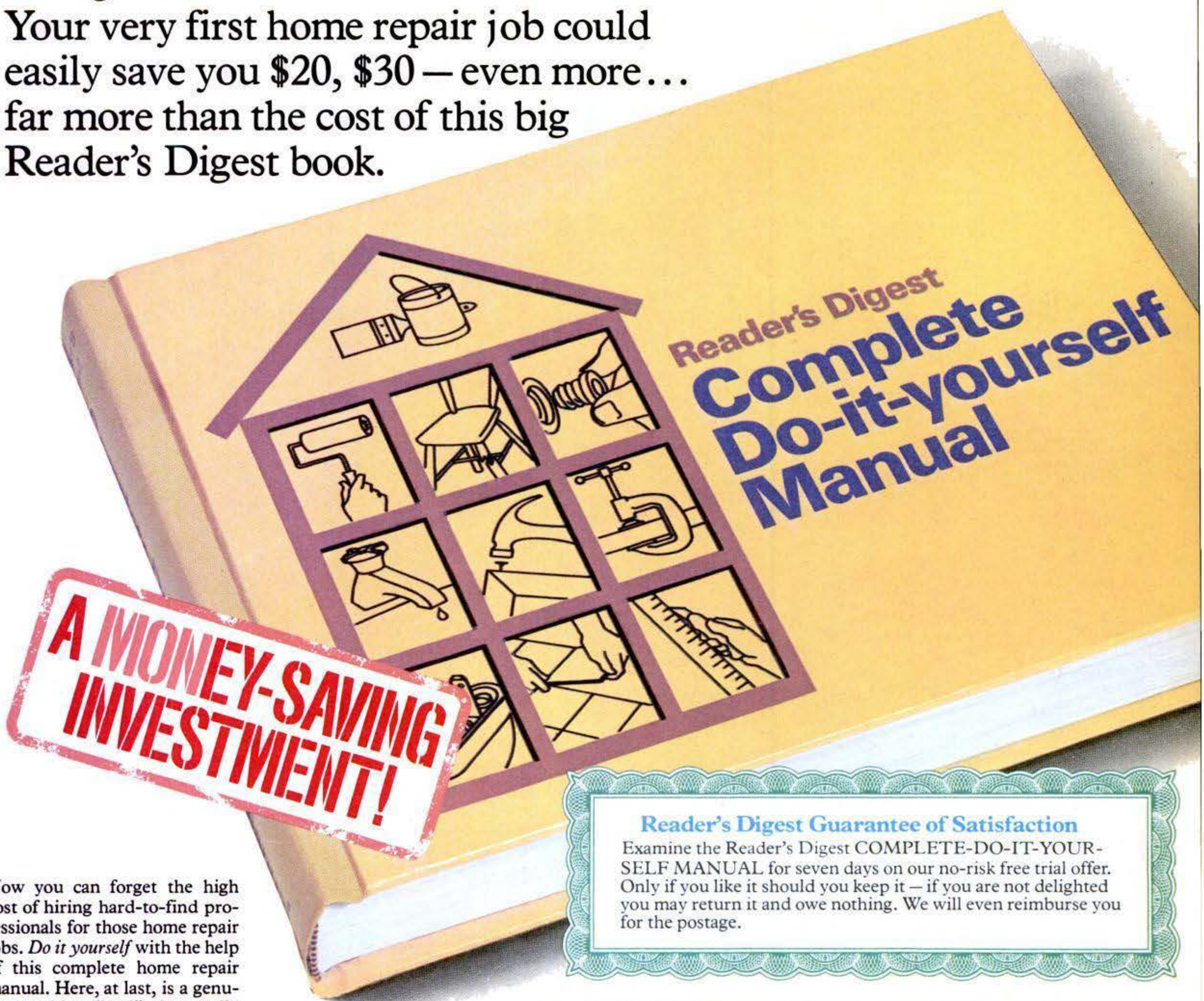

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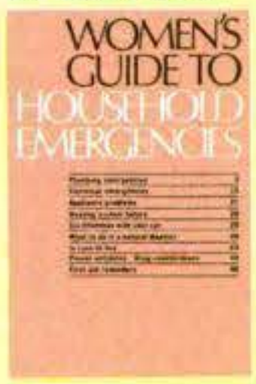

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"By far the best of the repair books."

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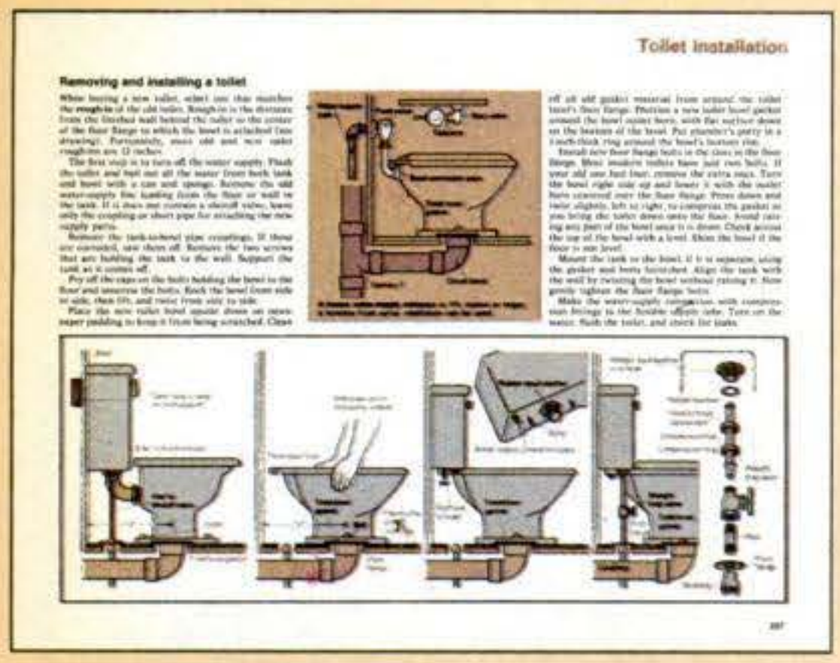
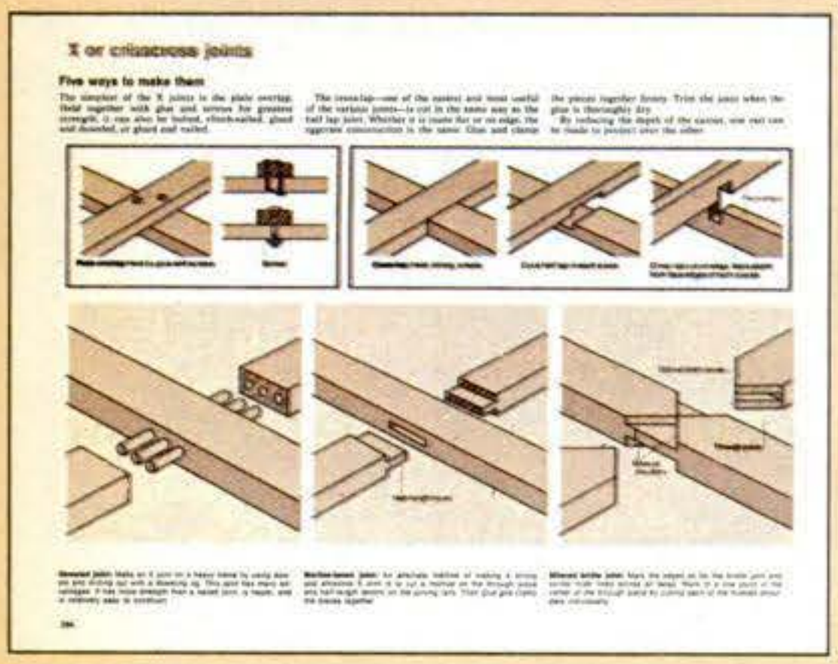
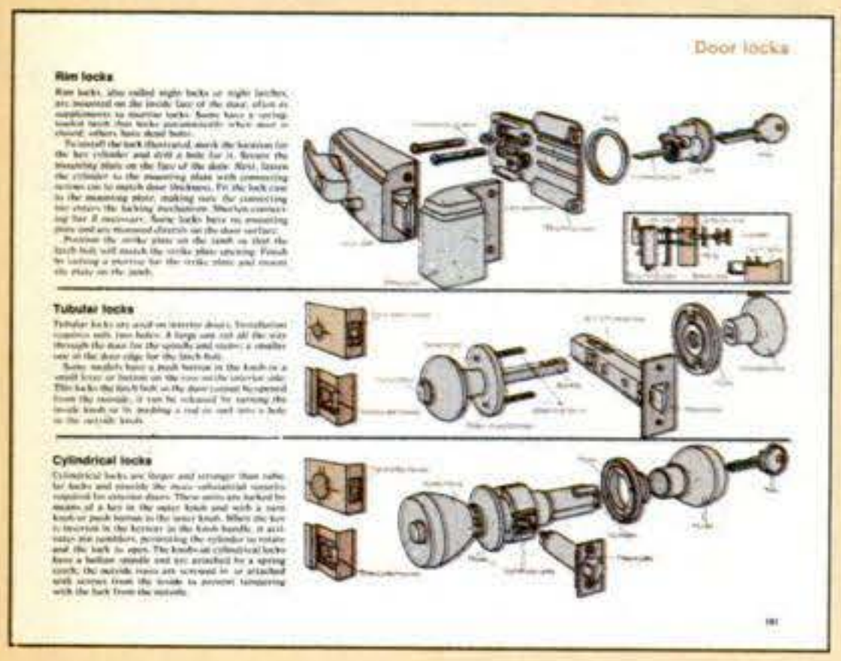
Reader's Digest editors scouted up the best experts in their fields, had *them* contribute to the *Complete Do-It-Yourself Manual*... then the editors took the experts' know-how and put it all into readable form — translated it from technical jargon into easy-to-understand pictures and language that even the beginner could put to immediate, mistake-free, good use.







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Handyman's techniques
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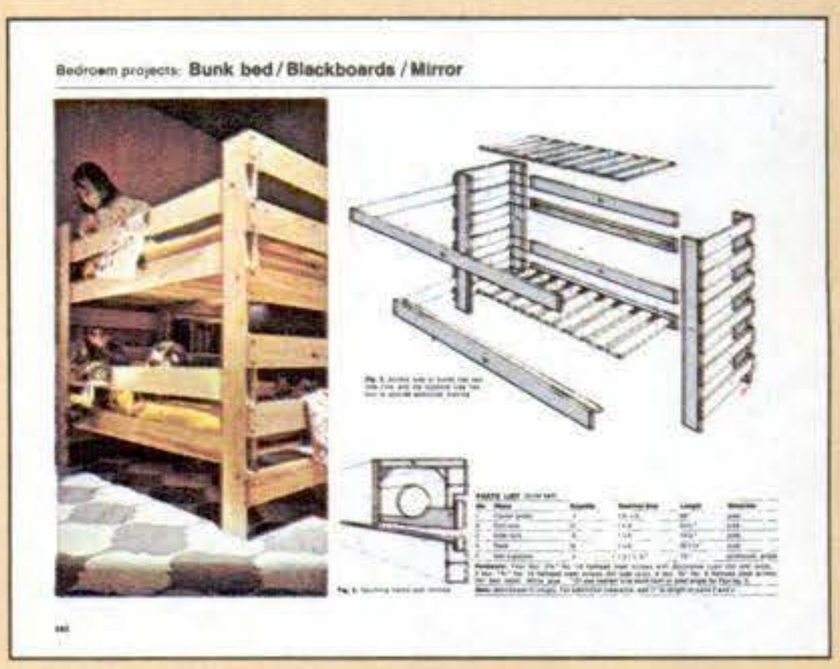

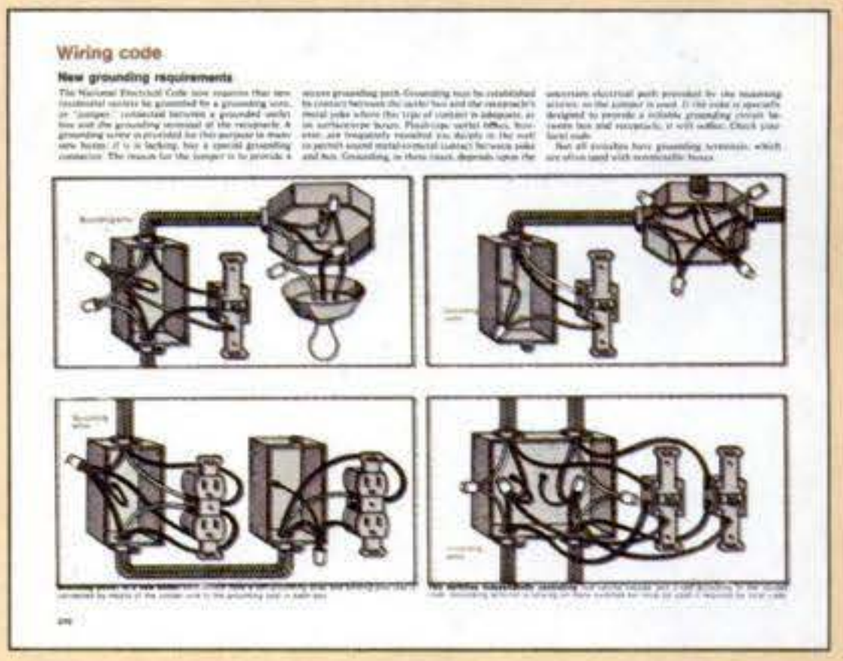

How to beat the high cost of skilled labor and "house-call" fees — some typical examples:

THE JOB	THE QUOTED PRICE	BASIC MATERIALS NEEDED	COST OF MATERIALS	YOU SAVE
Fix a leaky faucet	$ 16.95	Box of washers	$ .35	$ 16.60
Install a new wall outlet	33.90	BX cable, box, outlet, plate	6.50	27.40
Replace a 12" x 16" window pane	12.95	Glass and putty	1.65	11.30
Install a door lock	44.00	Lock mechanism	17.00	27.00
Hang a dining room light fixture	13.50	Roll of electrician's tape	.20	13.30
Paint ceilings in two rooms and hallway; paint seven doors	266.95	Two gals. ceiling paint, one gal. semi-gloss paint, sandpaper, spackling, brushes, etc.	42.65	224.30
Wallpaper 12' x 18' room	133.95*	Paper-hanging kit, paste	9.35	124.60
Tile a 12' x15' kitchen floor	360.00	Tile and cement	158.65	201.35

*Cost of wallpaper not included.

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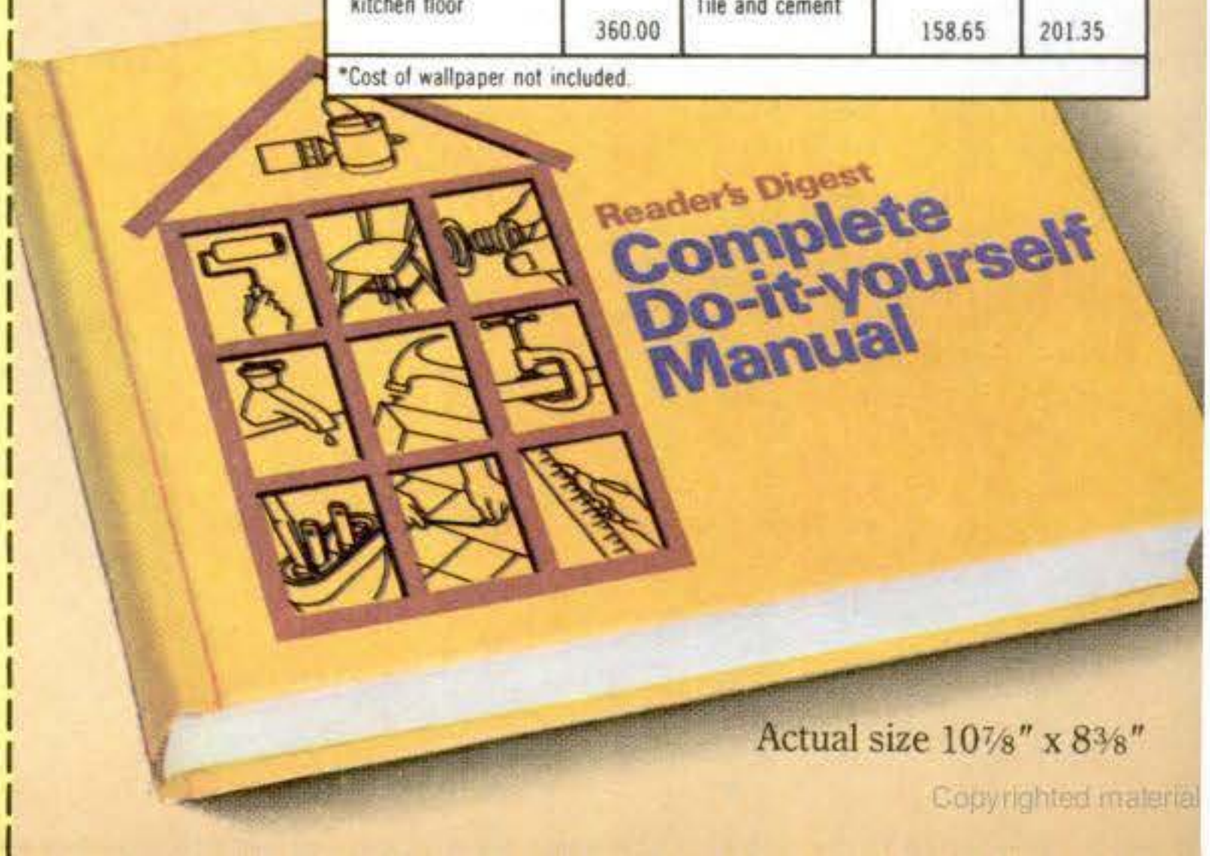

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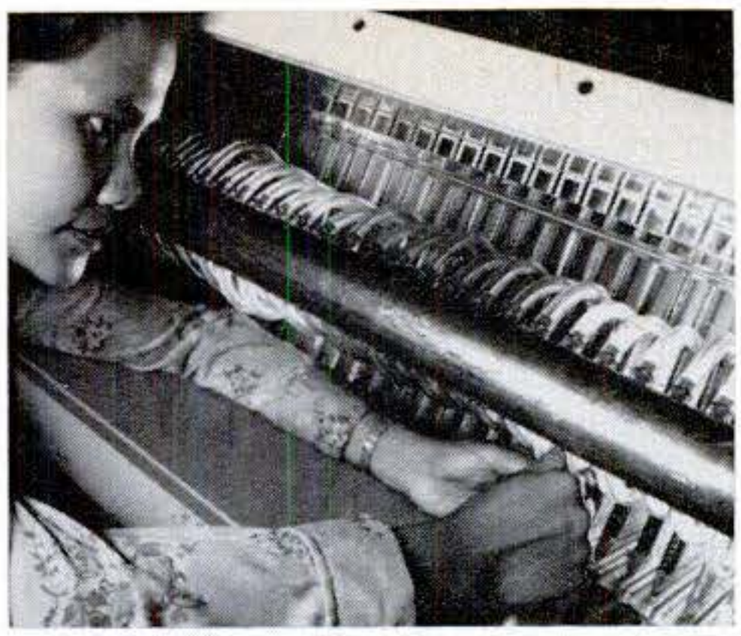

Oxygen-enriching membrane
cuts gas-heating bills

A semipermeable membrane that boosts air's oxygen content promises to cut natural-gas consumption in certain heating processes—and reduce costs. Still in the experimental stage at General Electric's research and development center, a range of membranes is being designed for different industrial applications.

The membrane achieves a more efficient permeation rate than current silicone-rubber membranes because it is thin—one thousandth of the thickness of a human hair.

A solid polymer film, the membrane has its pressure gradient increased by a vacuum pulling from the product side. Room air is absorbed into the membrane, dissolves in the same way that oxygen does in water, diffuses through, and is desorbed—oxygen-enriched.

At the GE center, room air is passed through a network of tubes (photo) to the membrane. Oxygen-enriched, it is then piped to a burner, where the hotter flame it produces when mixed with combustion fuel can halve fuel consumption.

Most industrial applications will require an oxygen content of 30-40 percent. "We've developed membranes," Shiro Kimura, manager of the membrane project at GE, said early this year, "with a range of selectivity capable of producing oxygen contents of from 30 to 50 percent. Enriching the air to 50-percent oxygen, then diluting it with ordinary air, means you need less of the product gas. The less product gas you make, the lower the total flow rate—and the less power you use."

When the system is available—and GE promises a daily production of 72,000 cu. ft of air enriched to 33-percent oxygen—the tiny membrane could be a convenient way to save fuel.—*Bryan H. Berry*

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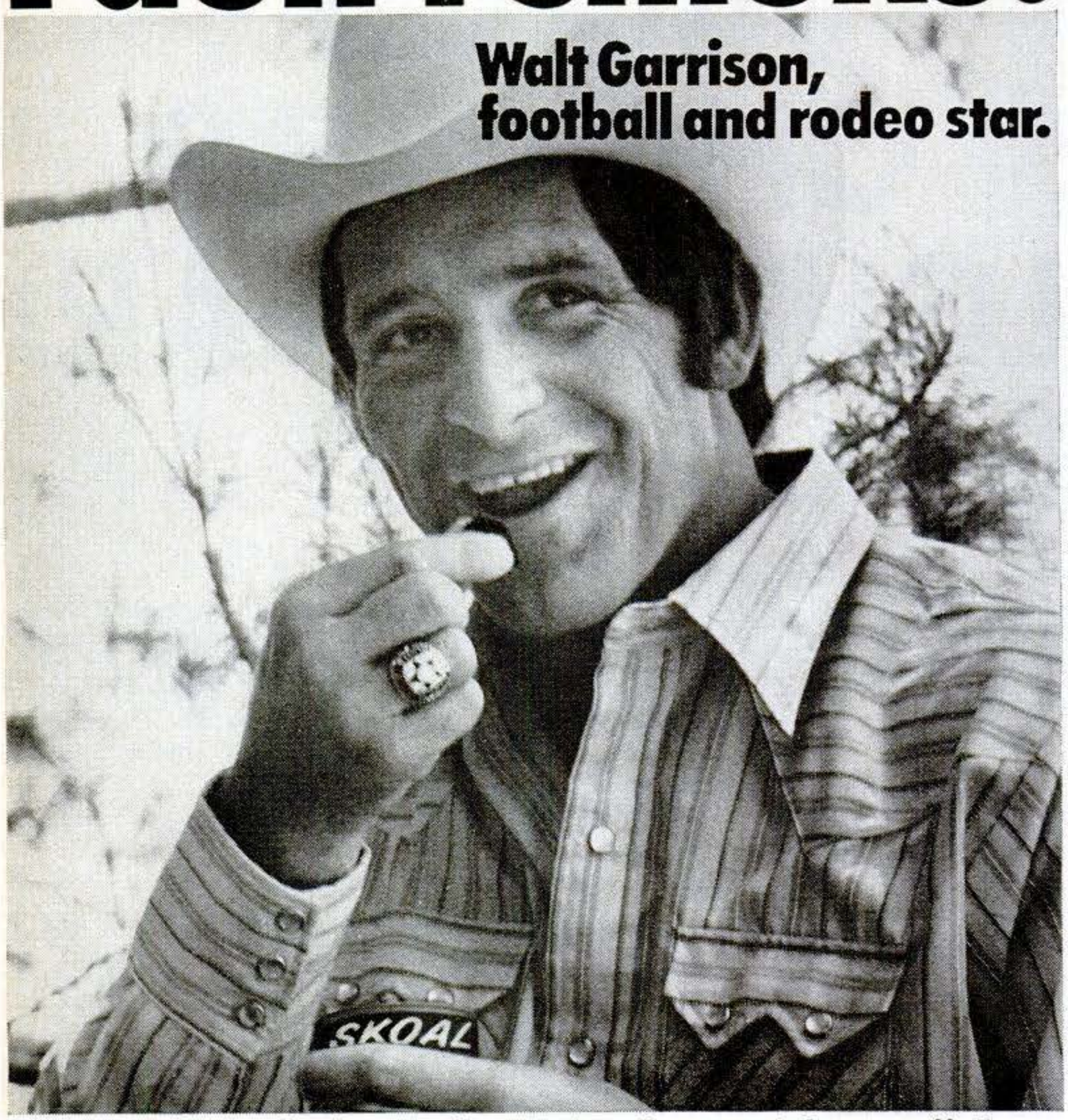
I love tobacco. I don't smoke.



I'm a guy who loves tobacco, but I never take a puff. I use smokeless tobacco instead.

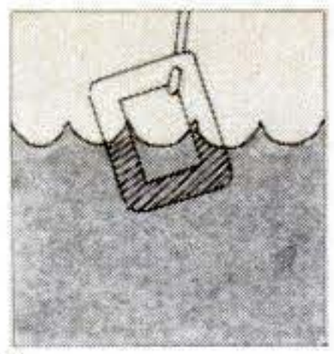
Just a pinch of smokeless in between my cheek and gum gives me full, rich tobacco pleasure. Feels real relaxing in there. And smokeless tobacco can't tie up my hands. So I can enjoy it no matter what I'm doing.

If you want to go smokeless, there are three brands to look for. Skoal, my favorite, with a wintergreen taste. Copenhagen, a straight tobacco. And Happy Days Mint.

All three are dated for freshness. All three are tobaccos you enjoy without smoking.

Smokeless tobacco. A pinch is all it takes.

For a free booklet that explains how to get the full enjoyment of "smokeless tobacco" —as well as a few free pinches that you can try for yourself—write to "Smokeless Tobacco," United States Tobacco Company, Dept. P66, Greenwich, Connecticut 06830.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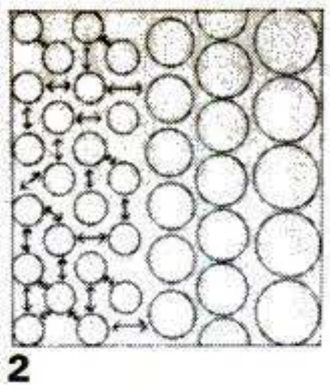
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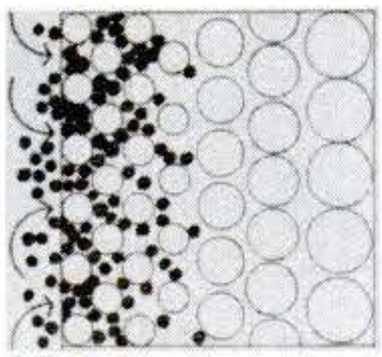
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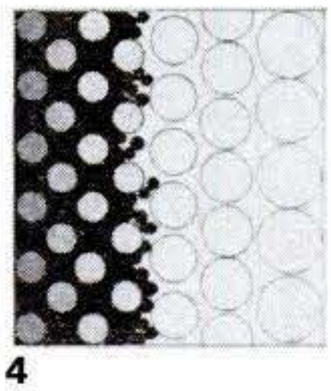
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Tough new coating channels Shuttle's waste water

What will happen when the astronauts use the Shuttle's liquid-waste system? Without a unique way to dispose of these wastes, zero gravity would keep the liquid suspended in air—the drops floating about until they hit a surface.

This won't happen, thanks in part to Tuframm, a lubricating coating developed by General Magnaplate Corp. (Linden, N.J.). The phase separator that handles the Shuttle's liquid waste is made of Tuframm-coated aluminum. Designed by GE's Space Systems Division, the unit works like this: A stream of air captures the liquid, directing it into the separator. An impeller moves the air/water mix to a centrifugal pump that separates it. The water is pumped to a holding tank; the air is filtered and recirculated.

Tuframm's role? It makes the separator's parts so slippery that water flows freely, instead of pooling up and clogging the system. The coating also hardens the metal surface and seals it against corrosion. A final dividend: Tuframm-coated aluminum is 60 percent lighter than stainless steel, the alternate metal considered for the separator.

Unlike its kitchen cousin, the Teflon used on fry pans, Tuframm is part of the metal. In the coating process (shown above), aluminum is first cleaned and prepared (1), then anodized to expand the surface crystals (2). Teflon is infused into the aluminum (3) and a heat treatment permanently bonds the two materials tightly together (4).

In an industrial use of Tuframm, the tough coating is used to extend the life of aluminum parts on assembly lines.—*Susan Renner-Smith*

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- SO LOADED with fruit you'll pick a "dessert-a-day" spring 'til frost.

AND THEY MULTIPLY — SO YOU GET TWICE AS MANY CLIMBERS EACH AND EVERY YEAR

— AND REMEMBER — because this SUPER CLIMBER is a self-multiplying perennial, for every berry-laden climbing vine you get this year, you'll get twice as many GIANT CLIMBERS next year . . . and every year to follow. Meaning: HUNDREDS UPON HUNDREDS OF BERRIES year-after-year-after-year!

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THINK OF IT! YOU PLANT THIS SPRING — PICK BERRIES BY THE BUSHEL STARTING IN JUST 55 TO 60 DAYS!

And remember — because they're winter-hardy, (even in Northern Canada) — because they're disease and virus resistant — they're one of the sturdiest, easy-to-grow strawberries imaginable. Just drop them in the ground next to any fence, trellis, wall, or even a pole . . . and they train so easily as they march themselves right to the top in an incredible parade of fruit, flowers, and foliage. It's one of the most spectacular sights in all of nature.

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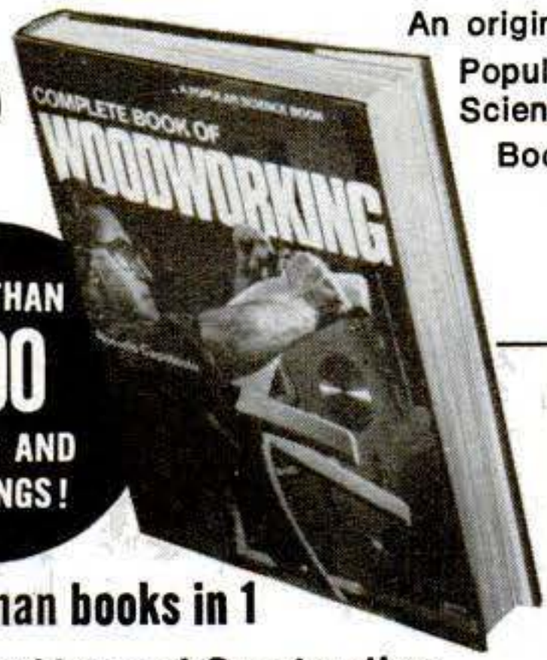

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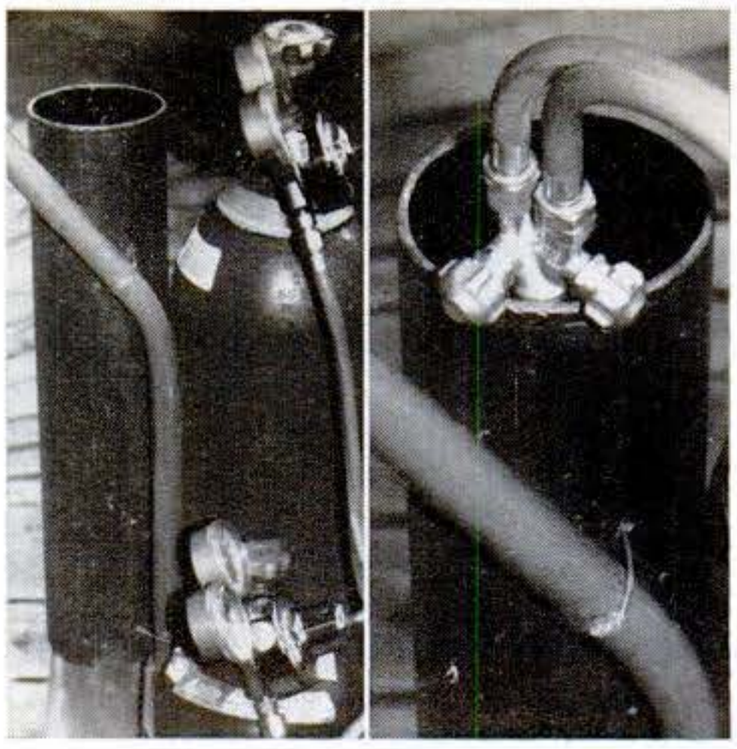
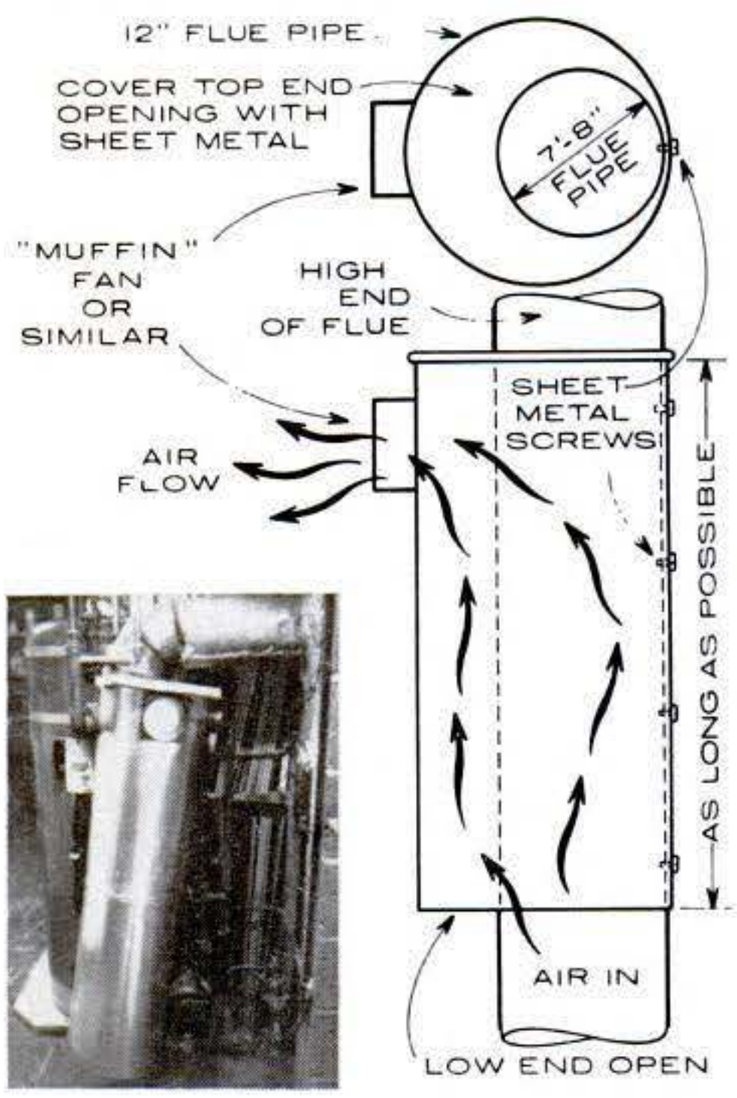


Torch holster
for welding rig

It's easy to add a holster to your welding cart that gives an idle torch a secure seat on its valve housings, with the tip hanging free. Wire an 18" length of 4"-i.d. ABS sewer pipe to the handles, top and bottom, so it rests on the tray. I used #8 copper wire looped through ⅛" holes.—*Robert Deasy*

Stack heat exchanger
saves fuel



Economically constructed of a section of flue pipe topped by sheet metal, this heat exchanger provides enough hot air (45 cfm at 110° F while furnace is on) to heat my basement. Fan, connected to same wires as the burner motor (or to thermostat), draws cold air from the floor. To prevent dangerous flue-gas leaks, seal screw-holes drilled in the stack.—*Harry B. Fuge*

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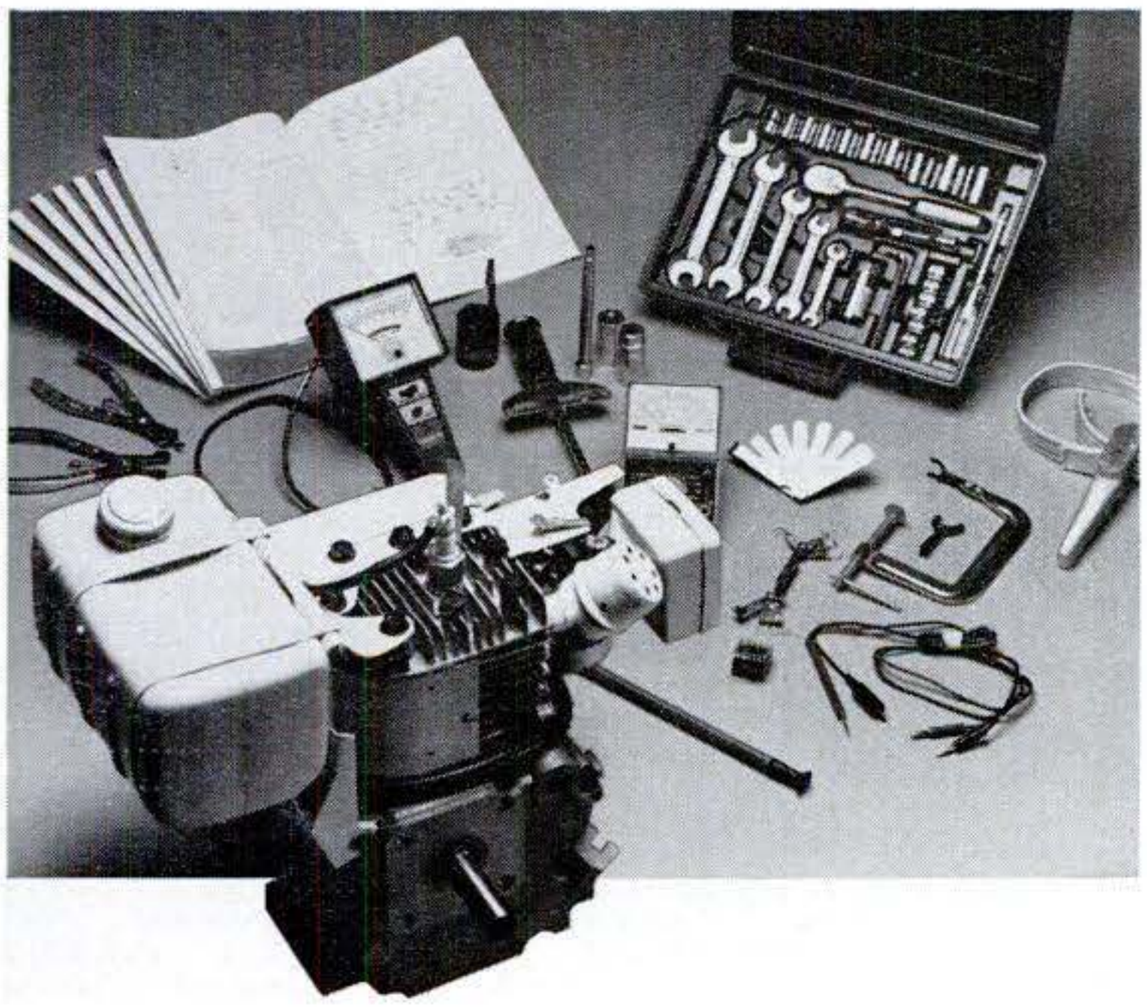

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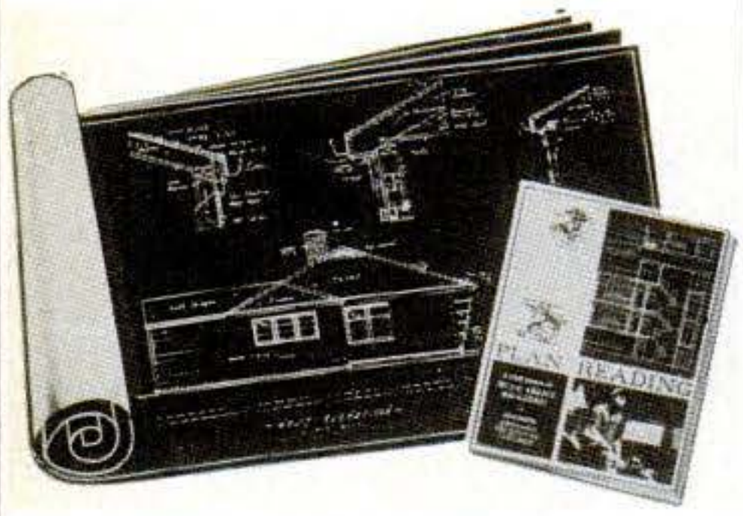

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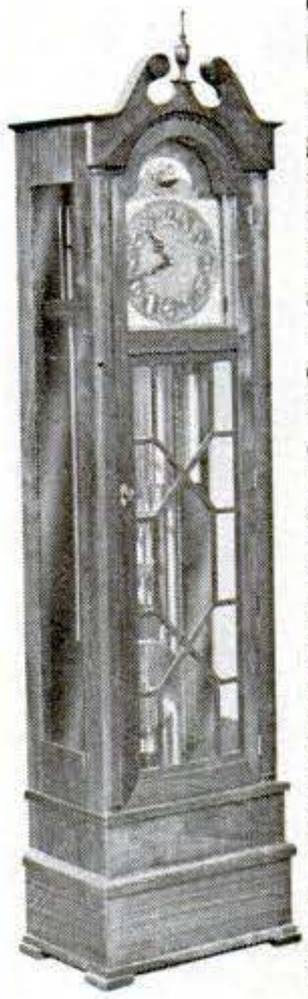

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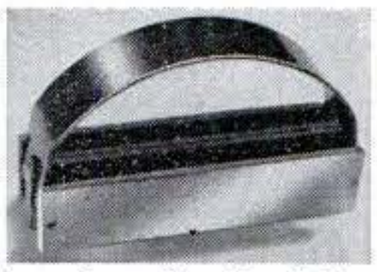

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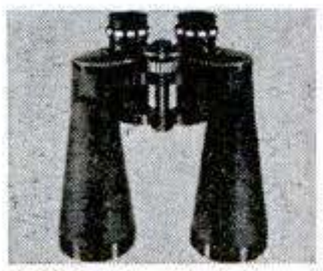

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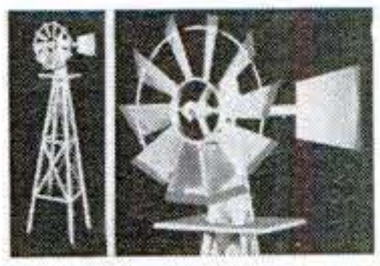

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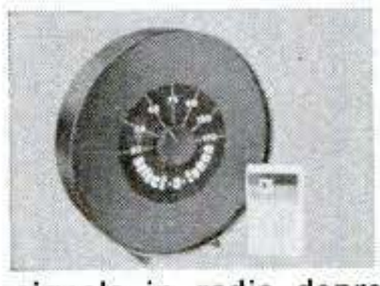

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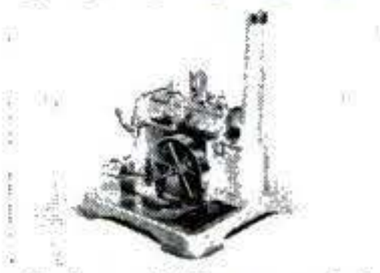

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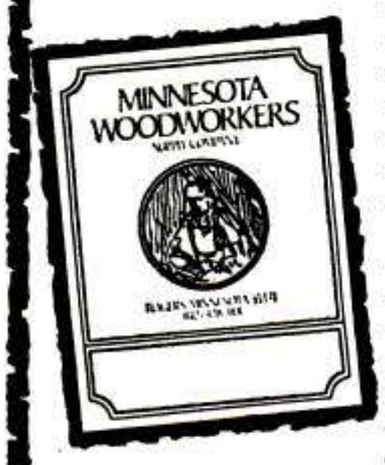

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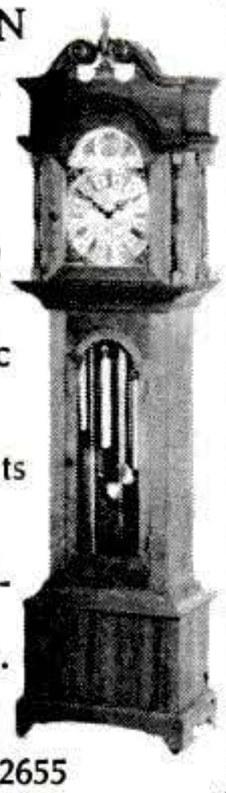

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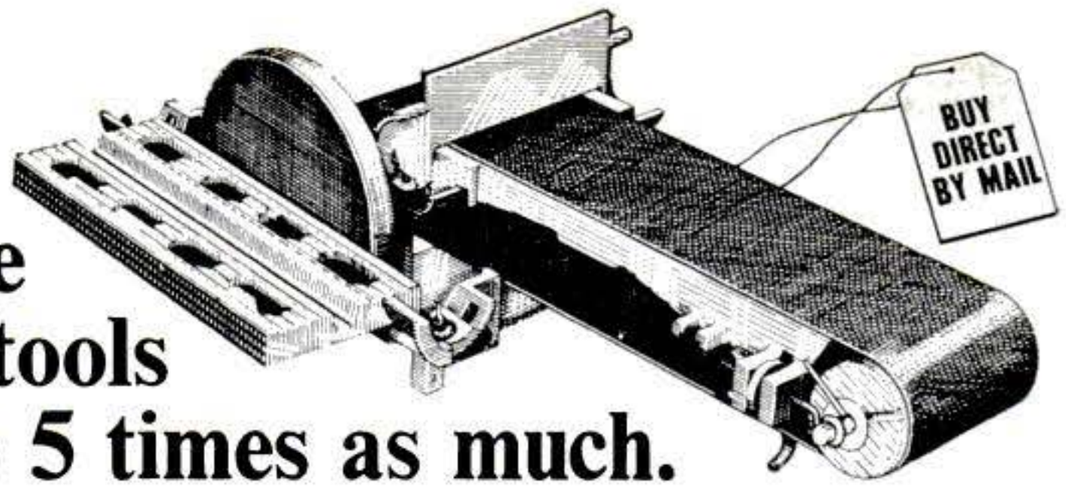

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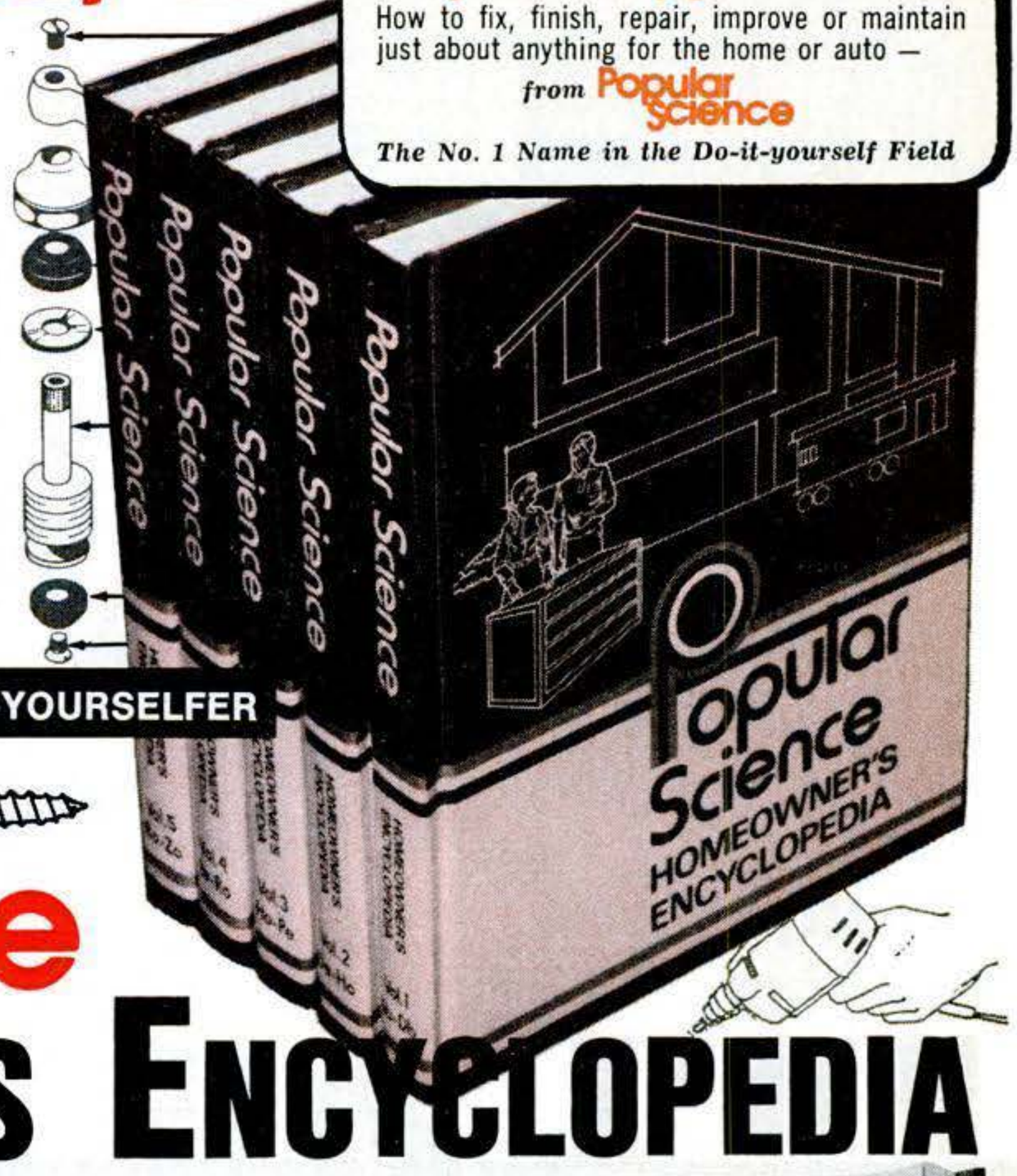

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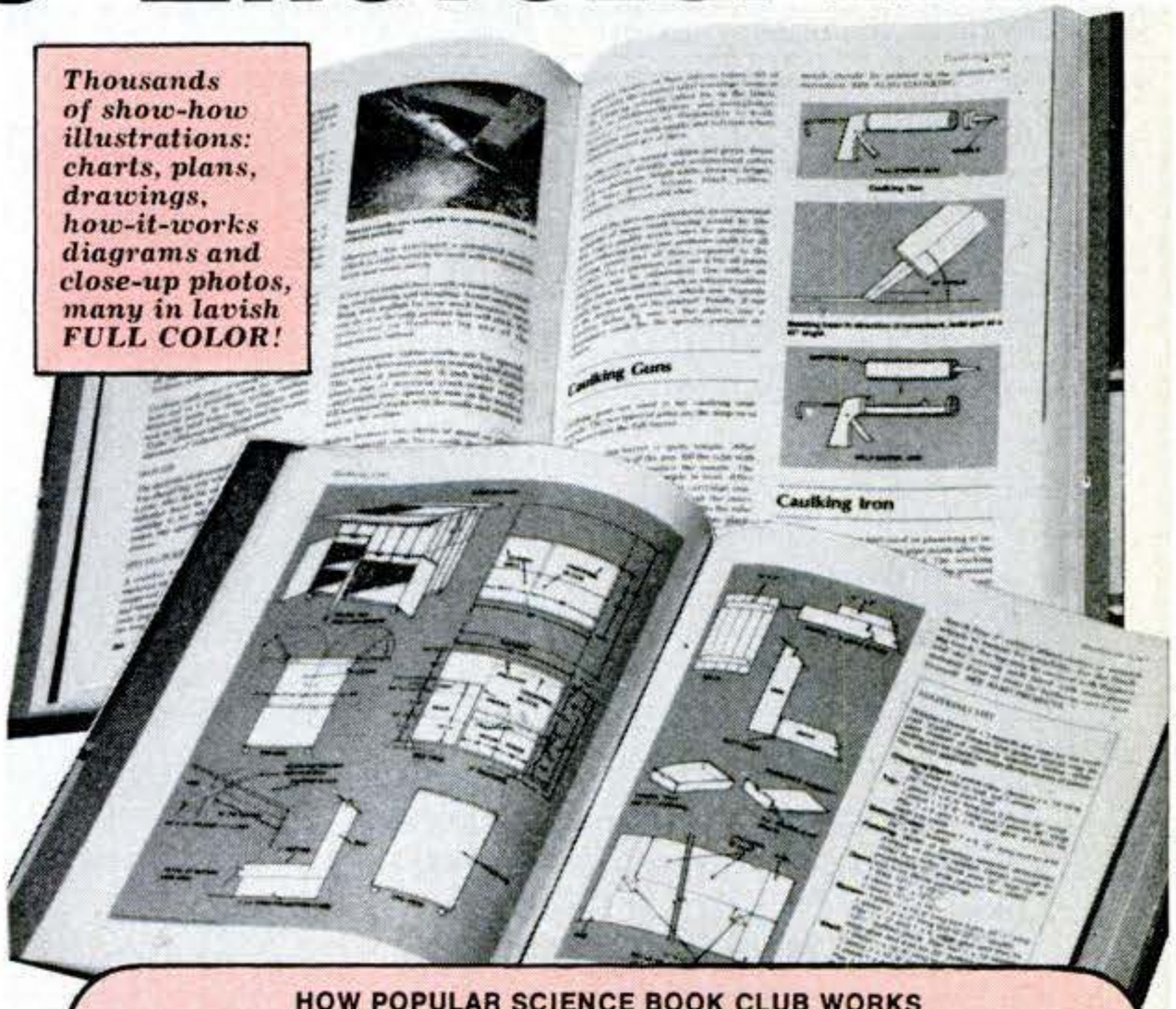

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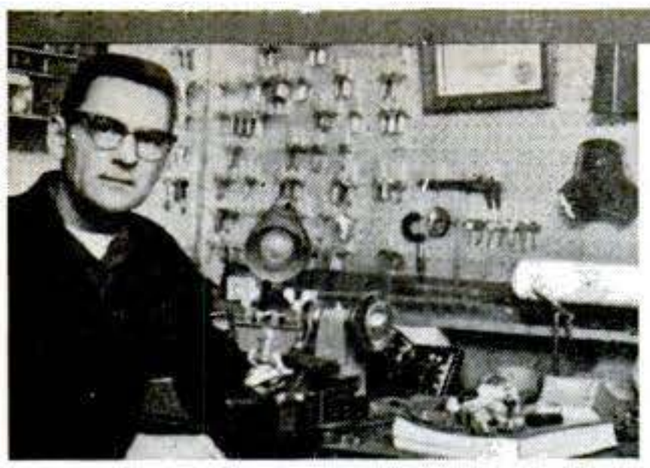

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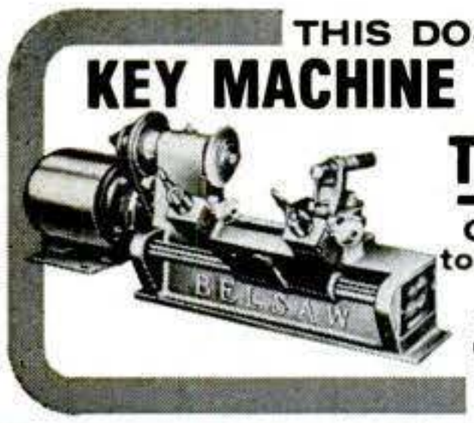

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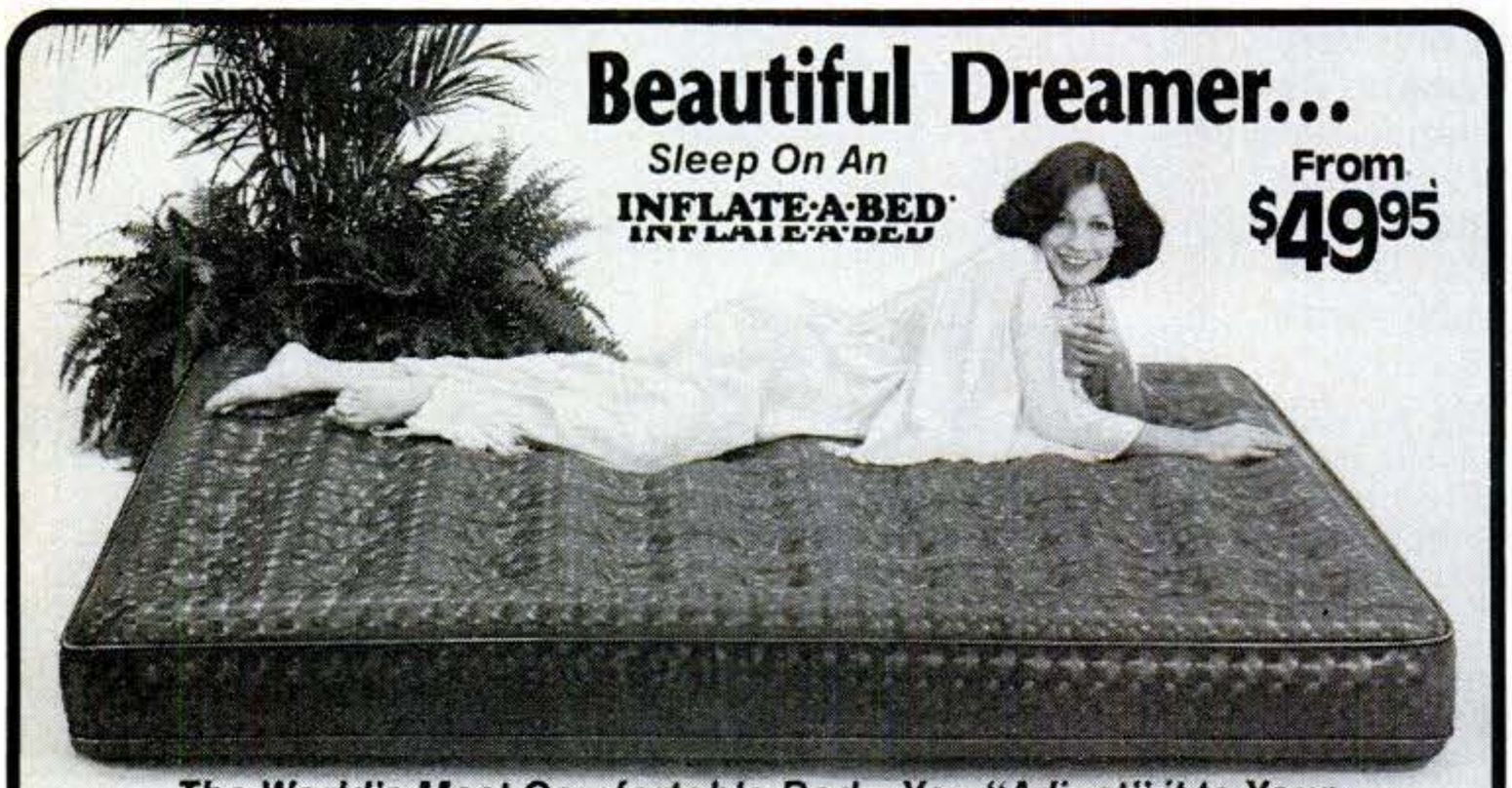

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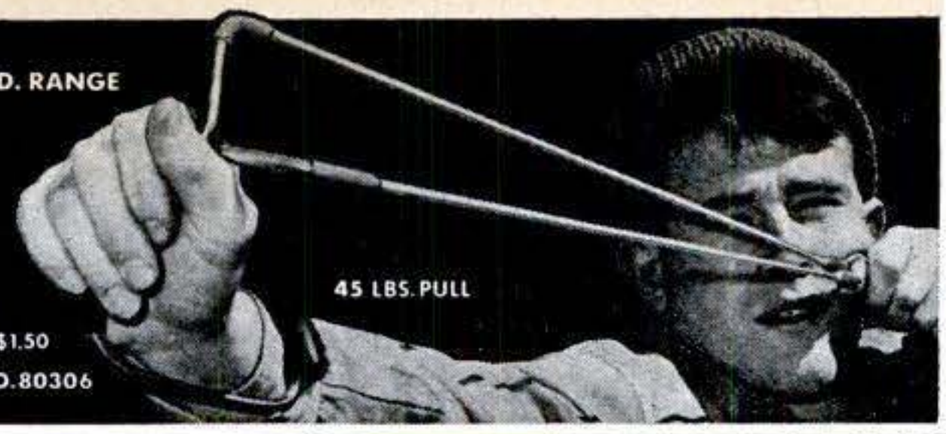

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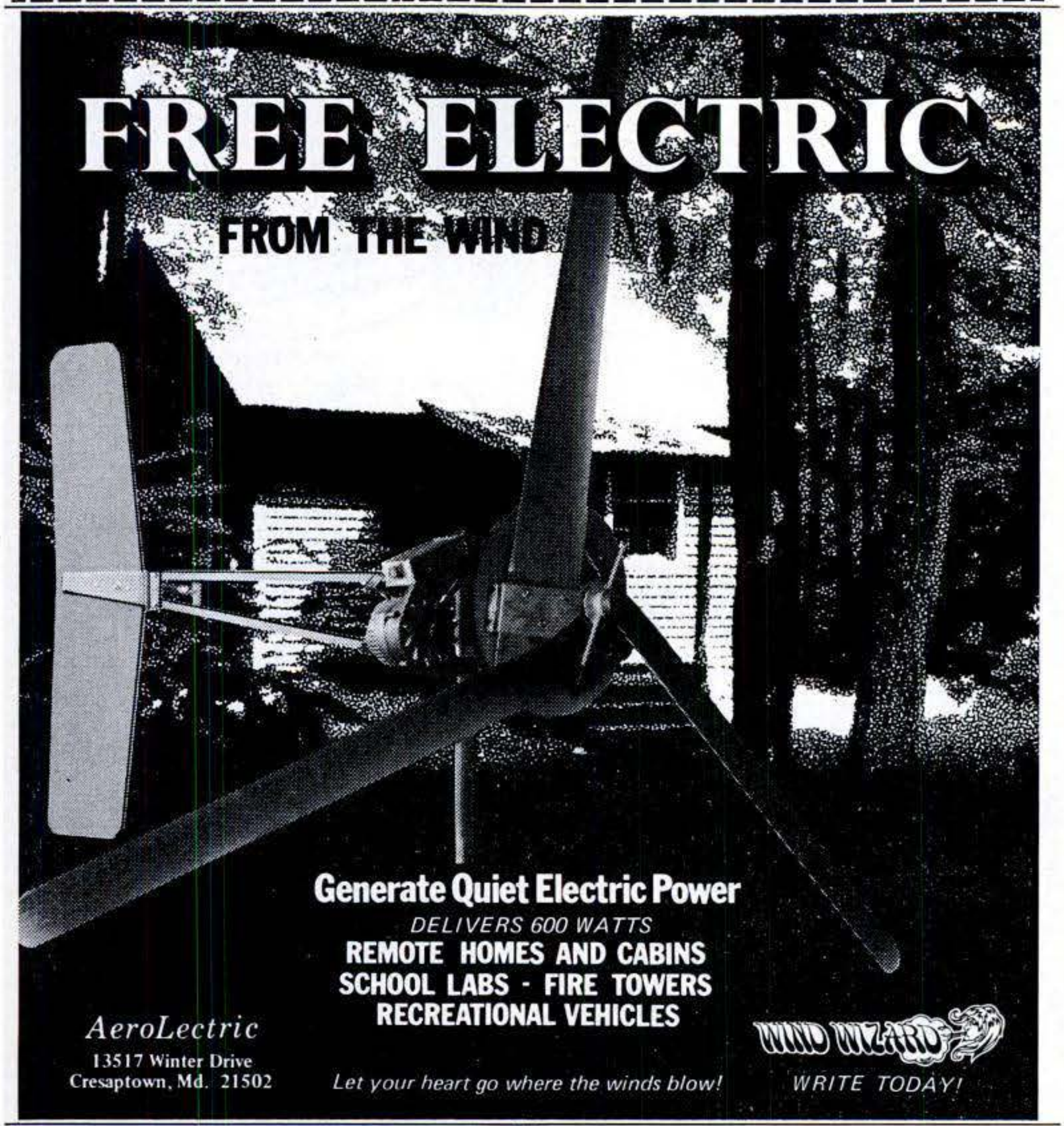

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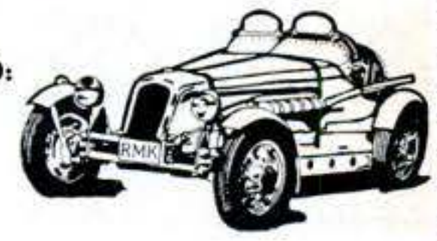

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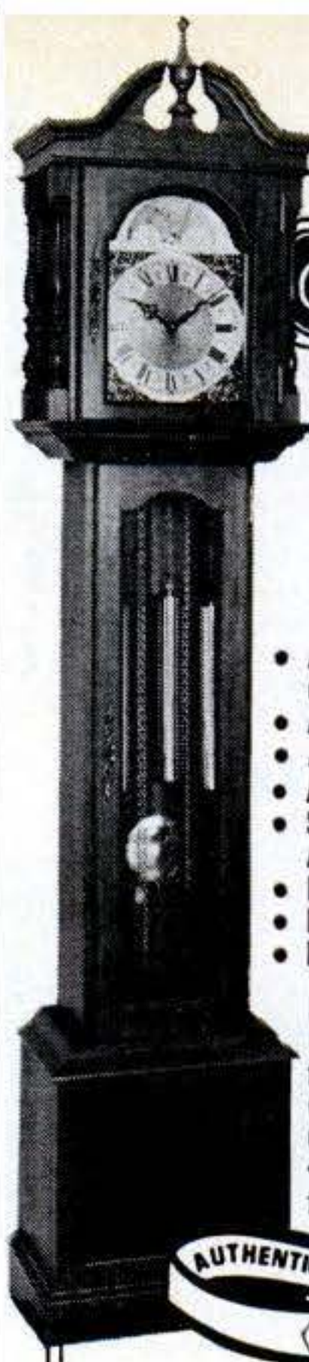

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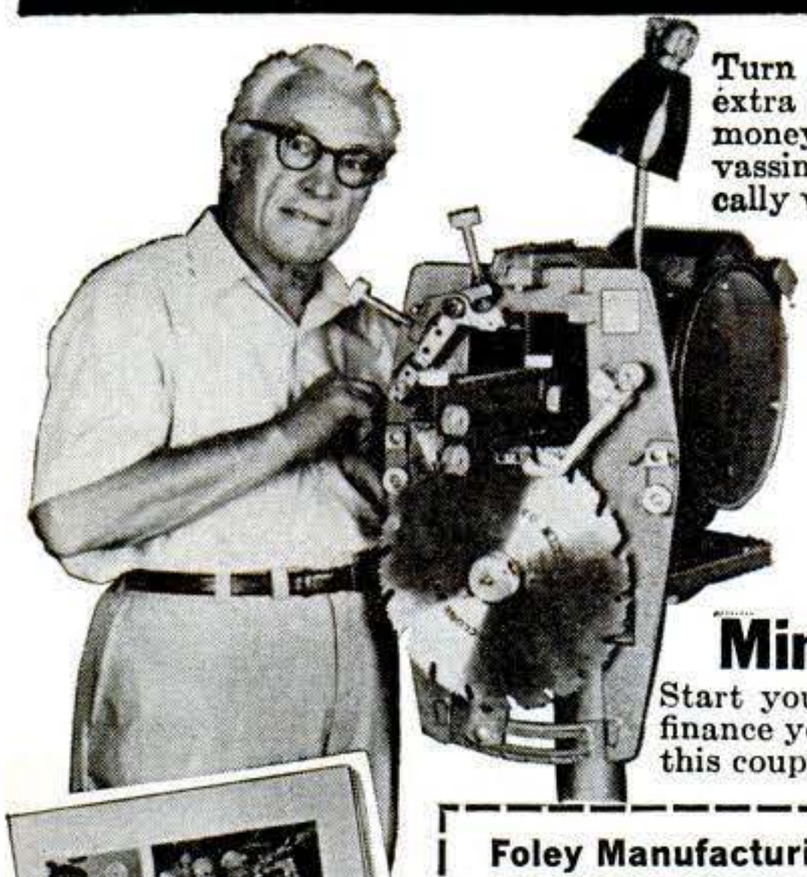

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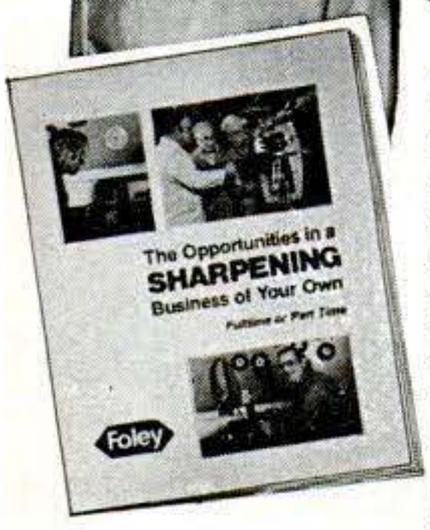

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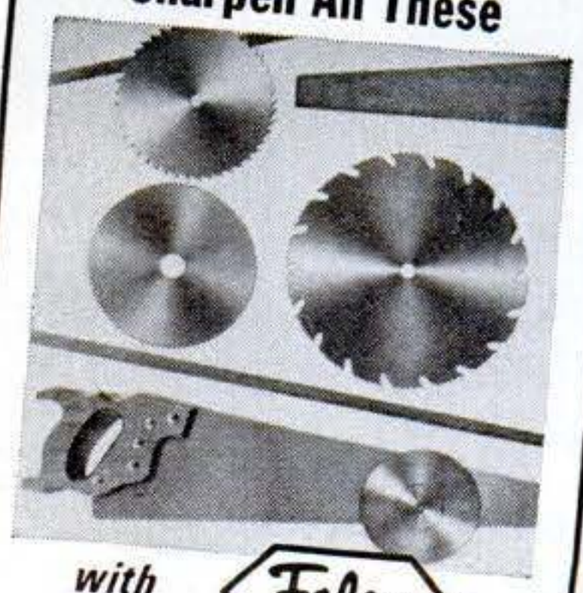

with versatile Foley® **Saw Sharpeners**

You can sharpen combination (rip and crosscut) circular saws, band saws, hand saws, crosscut circular saws, steel or carbide tipped—and do a perfect job every time without experience or special training. Precision Foley Sharpening equipment does it for you automatically! Set up in basement or garage, work your own hours in your own way and earn big sparetime profits.

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HABAND'S Executive Club NO IRON

KNIT SLACKS

NOW 3 PAIRS for ONLY 17.95

And We Pay the Postage!

That's Only $5.98 per pair!! LESS than the old Factory Price!

INVENTORY CLEAN-OUT! *NOT ALL COLORS IN EVERY SIZE, but we will* **OVERWHELM YOU** *with* **UNCANNY VALUE** in **YOUR SIZE!**

Shop around! You will see that men are paying almost $17.95 per pair for good business dress slacks. Now here is an excellent savings opportunity. Haband, the famous mail order people from Paterson, N.J. will send you THREE PAIRS for $17.95, on direct money-back approval!

You just tell them your size, exact waist and inseam, and what colors you like. You have to send your check with the order. Then sit back and be amazed at the fast, dependable service and the buy of your life on high quality, better made executive knit dress slacks!

100% Polyester
NO IRON KNITS
3 pairs for 17.95

NOBODY WANTS TO MENTION ANY NAMES But these extraordinary values are too important to keep secret!!!

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10 YEAR LOW PRICE

Haband has been in business over 50 years. We serve over 2,000,000 active business & professional men direct by U.S.Mail.

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HERE'S WHAT YOU GET: Quiet, Conservative Colors and Quiet Conservative Tailoring ★ 100% Polyester No-Iron Non-Snag Knits. ★ *All Permanent Press NO IRON Machine Wash and Wear!* ★

Plus full professional model detailing like "Ban-Rol" no-roll waistband, deep strong no-hole front pockets. Neat set-in back pockets. Proper belt loops. Proper businessman's straight leg model. Hook type top closure. "Talon®" unbreakable Zephyr Zipper. Full Executive Cut – **THE WORKS!** *Just look! Haband slacks usually sell at prices like two pairs for $19.95 or 2 for 24.95. A price of 3 for $17.95 for the same quality is something you shouldn't miss! Send in a trial order!*

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Our Choice of Color*

3 PAIRS NO-IRON BUSINESS DRESS SLACKS 17.95 6 for $35

in YOUR EXACT SIZE!

FULL GENTLEMAN'S CUT in YOUR Exact Size!

Waist 29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54.

Inseams: 26-27-28-29-30-31-32-33-34.

HABAND COMPANY
265 N. 9th St., Paterson, NJ 07530

Sirs: Please send me ..... pairs of your NO IRON Executive Dress slacks, for which I enclose $ .....

GUARANTEE: *Your remittance back in full if on receipt you do not want to wear them!*

77S–033

Name .....
Street ..... Apt. # .....
City .....
State ..... ZIP CODE ☐☐☐☐☐

*Color Preference	How Many	What Waist	What Inseam
BLUE			
GREEN			
BROWN			
GREY			
GOLD			
Burgundy			

HABAND

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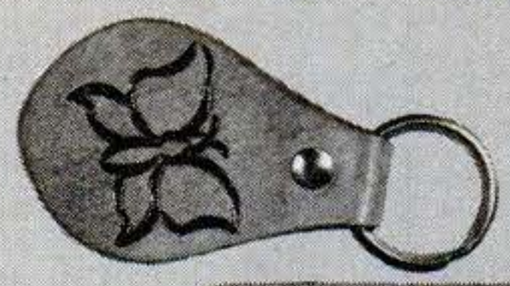
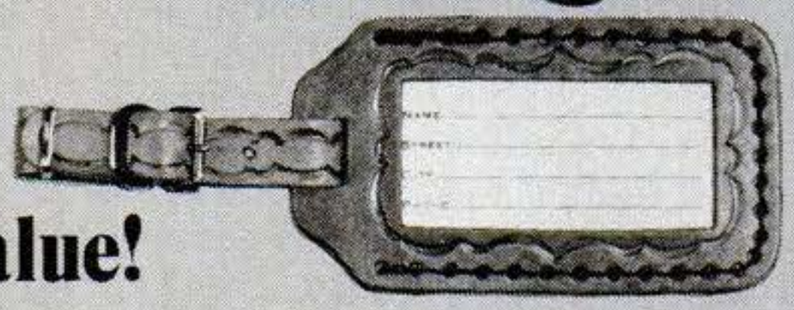


Only $1.95 with coupon below



A $6.00 retail value!

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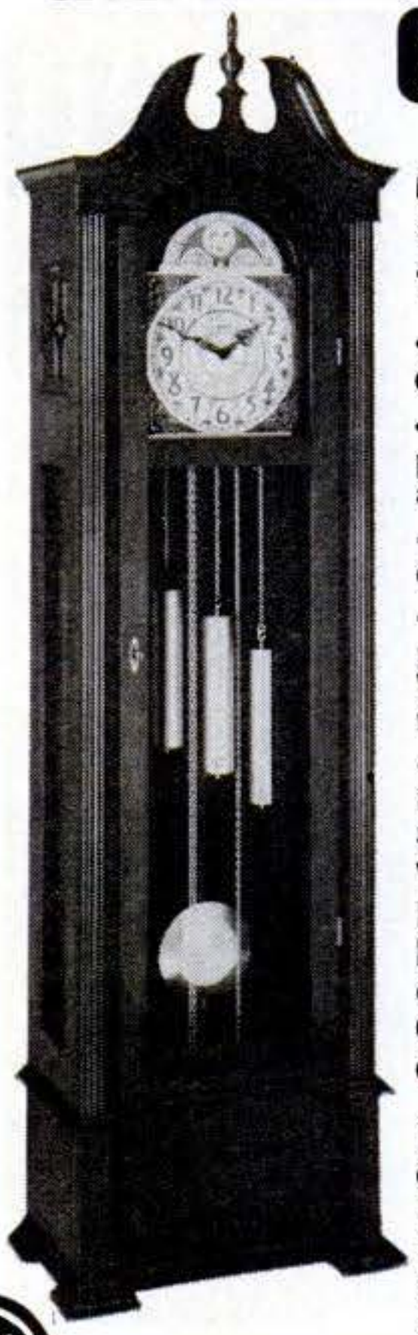

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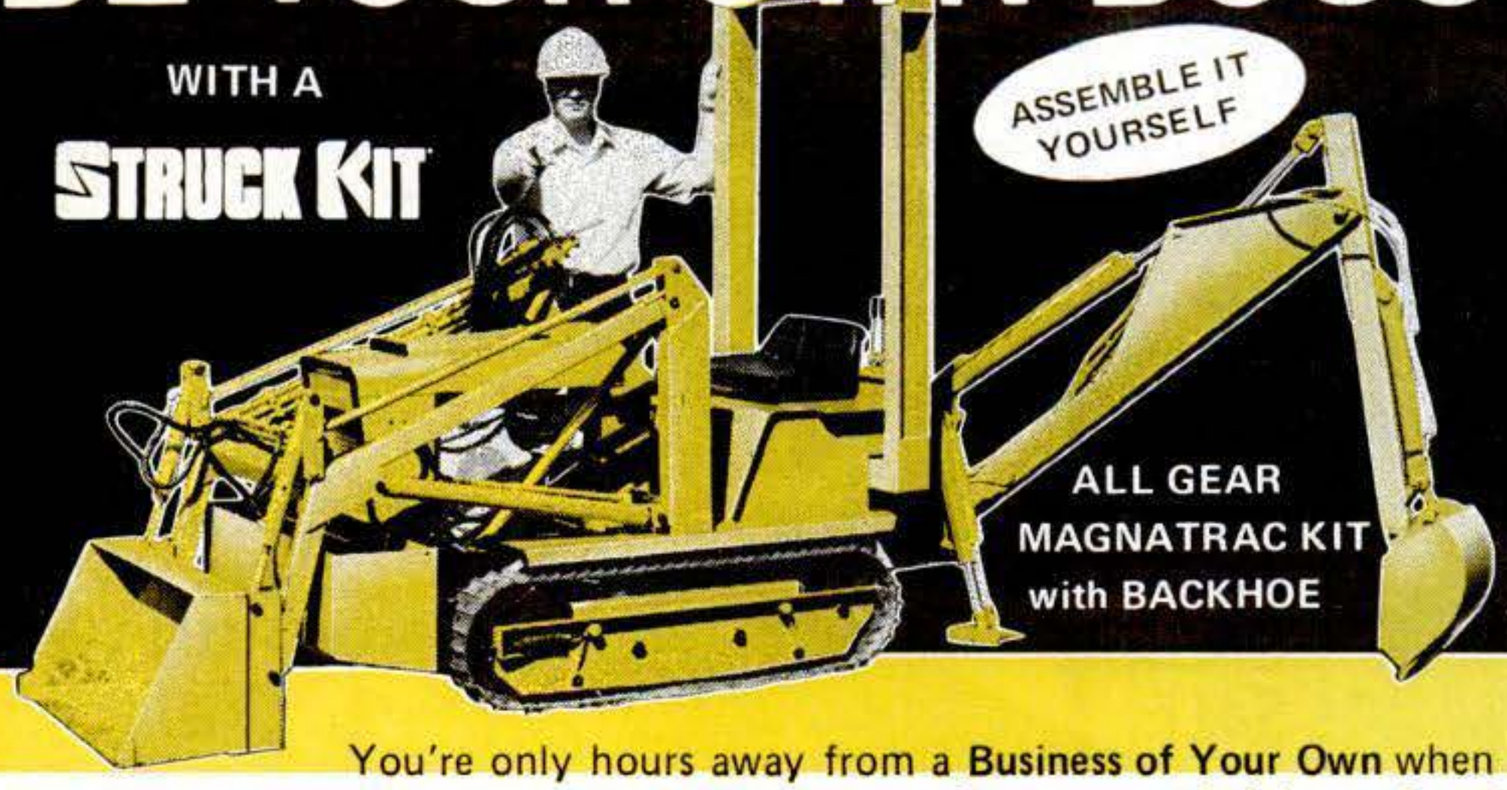

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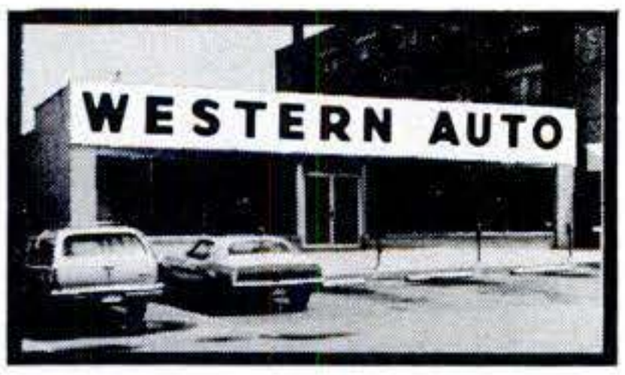

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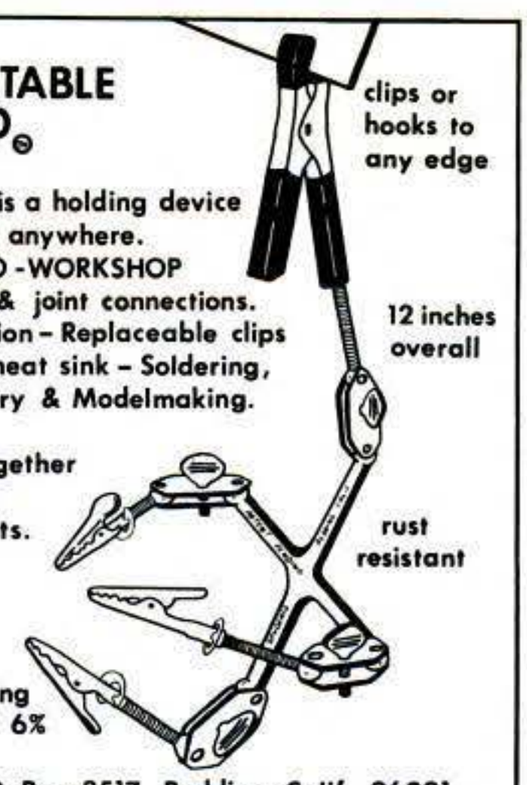

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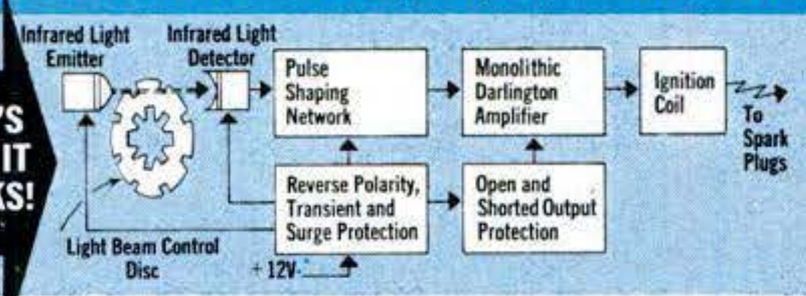

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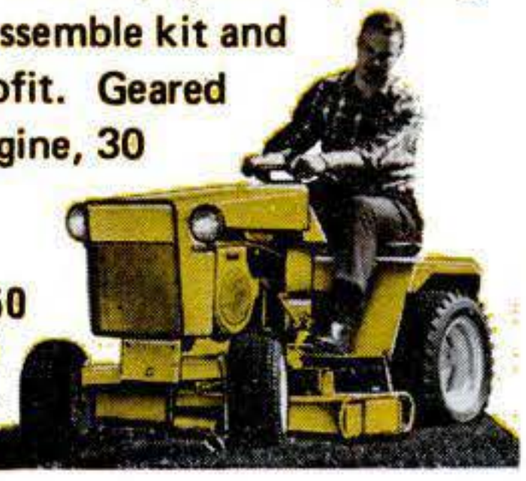

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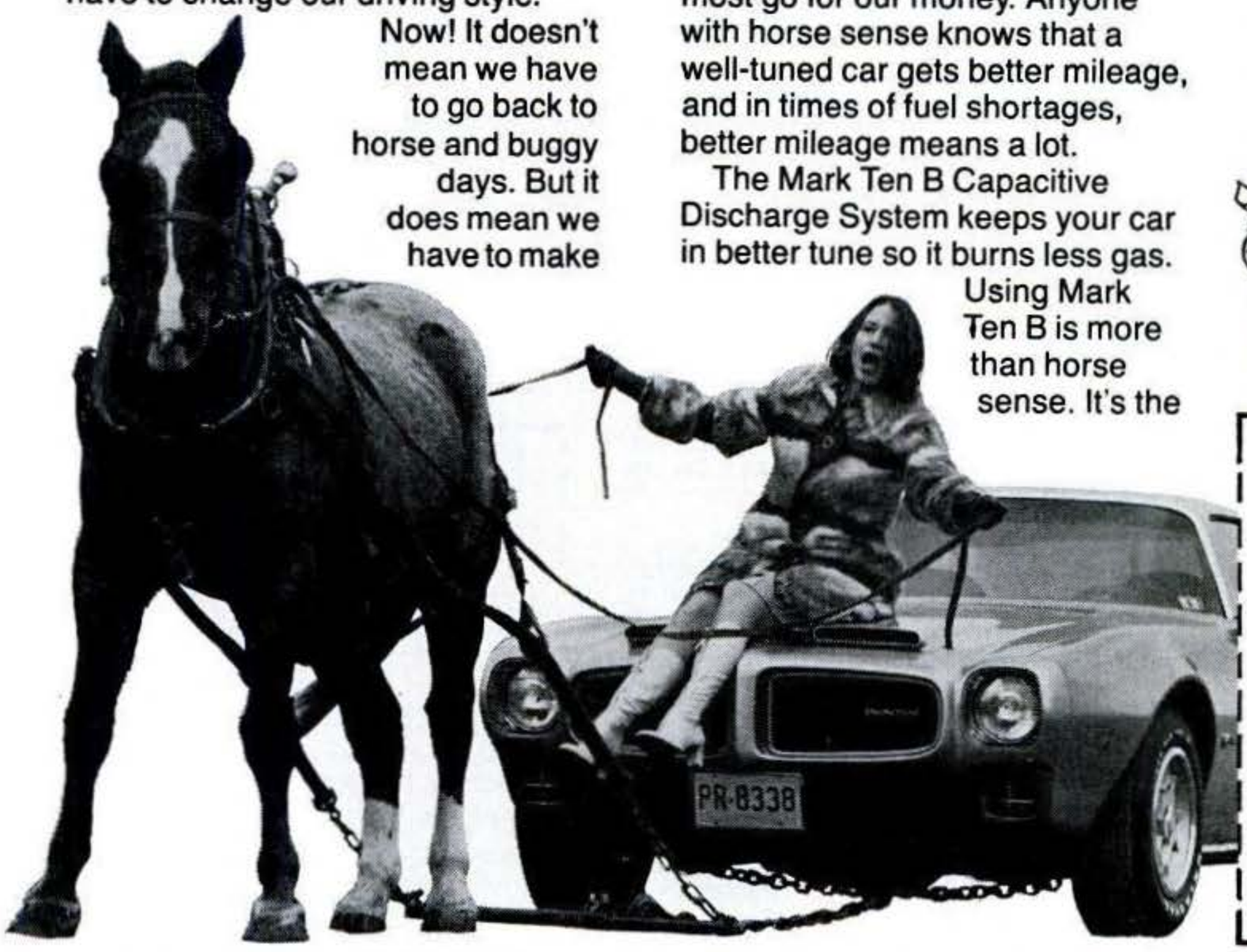

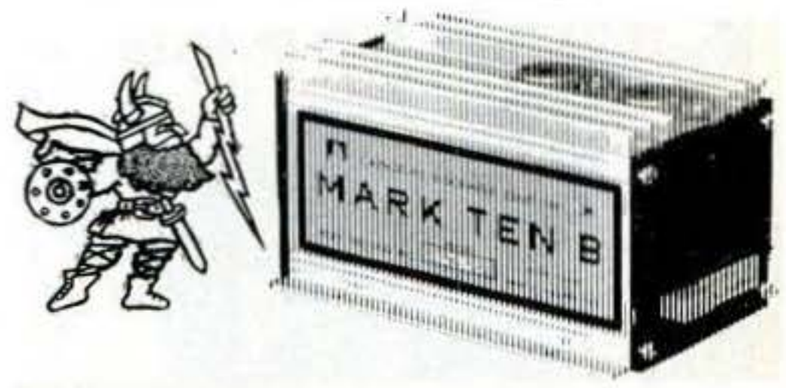

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I realize that today, there are so many weight loss products and programs on the market, that you are probably thoroughly confused as to which one is truly effective.

Everyone, both young and old is striving for that slim, sleek, youthful and energetic figure. The problem is how to achieve such a shape without damage to your health and at the same time keep your energy level high in order to cope with the tensions and rapid pace of today's world

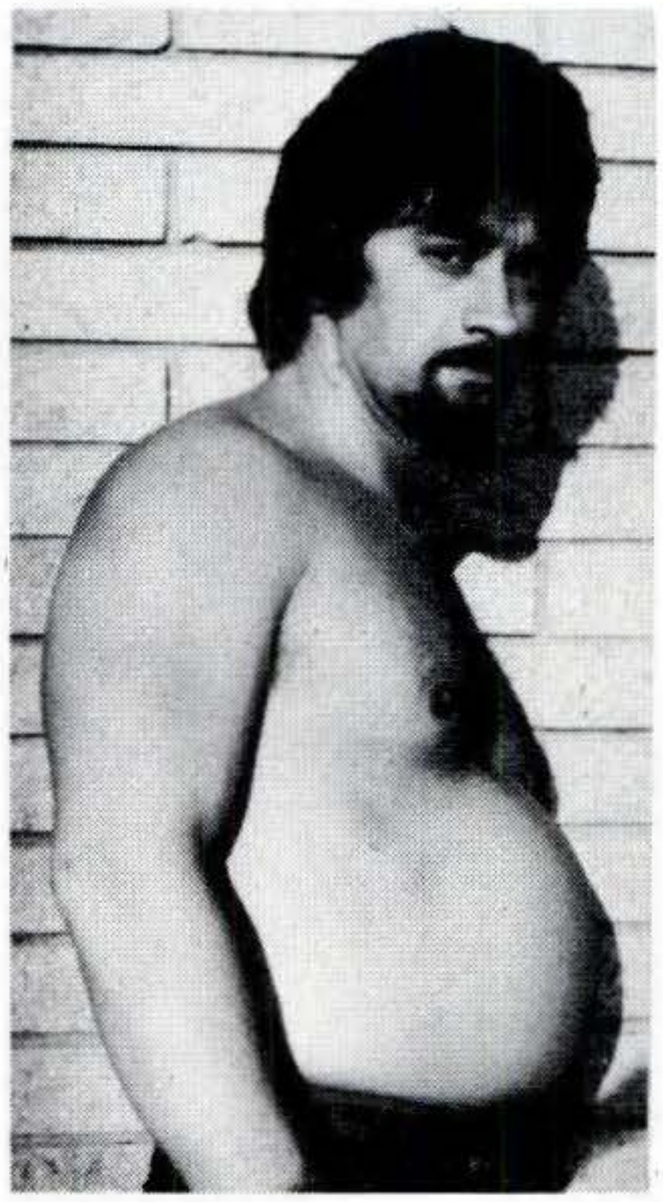
I have developed such a system!

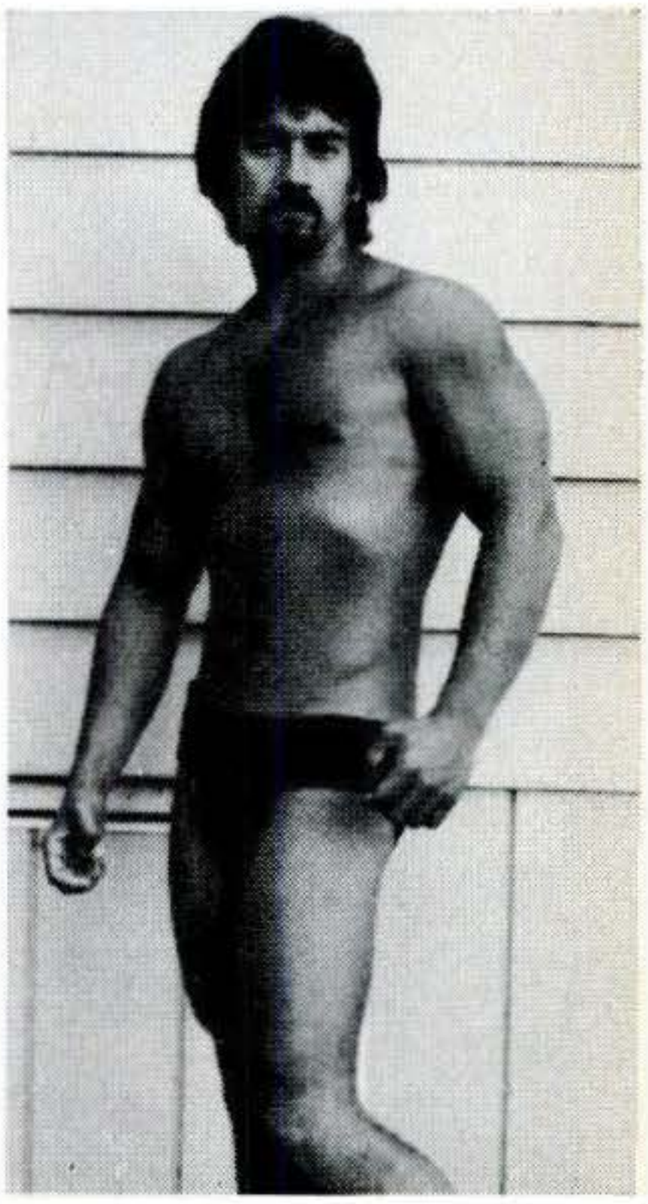
I firmly believe that this Amazing Fat Burning system is the most effective system ever. I should know, just take a look at my before and after pictures. I lost 18 pounds of ugly fat, in only 15 days.

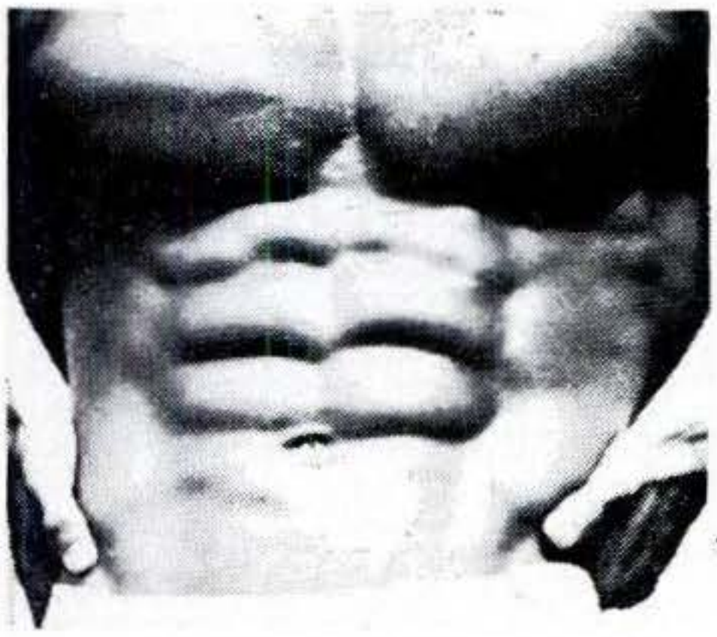
And, believe it or not, I kept my stomach full of food (no hunger pains).

And, my wife lost 40 pounds in only 30 days!

Since then, I have been continuously researching areas of nutrition, bodybuilding, and diet programs, in order to help thousands achieve that slim attractive shape desired by everyone. In fact everyone I put on this Amazing Fat Burning System, reported that they made fantastic weight loses--fast and easily!







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IS IT THE WORLDS FASTEST, MOST EFFECTIVE FAT BURNING SYSTEM EVER?

I sincerely think it is! Why? Because many of the principles and methods used are the same as those used by top physique champions to eliminate all excess fat.

In fact, many physique champions reduce their body fat to the extreme, so that the skin becomes almost paper thin. Certainly you don't want to become extremely thin. But, it's nice to know that the Fat Burning System can accomplish almost any weight reduction you desire. And isn't that what you want?

This system is so unique and effective (because it really works)--so much so, that we have had the system copyrighted with the US Government, so that the secrets cannot be copied and stolen!

MAN OR WOMAN--YOUNG OR NOT SO YOUNG--THIS SYSTEM IS FOR YOU!

Everyone can use this system, regardless whether you're young or not so young. It doesn't matter whether you're 10 or 100 pounds overweight, or how many times you have tried to get into shape. With this new system you'll lose weight faster than ever before. In fact you'll have more energy, strength and endurance so that you will feel younger and enjoy a fuller more active life.

I HAVE A SUPER EXERCISE FOR YOU! MORE EFFECTIVE THAN JOGGING!

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THIS AMAZING SYSTEM REQUIRES ONLY A MINIMAL AMOUNT OF YOUR TIME!

This system requires a small amount of your time (and some effort), but the results will be nothing short of miraculous! Our program offers you plenty of food to eat, plus supplements that will also help burn off the excess fat.

IF YOU REALLY WANT TO BE TRIM AND SLIM...AND WITHIN DAYS BEGIN TO SEE A REAL DIFFERENCE IN YOUR APPEARANCE--THEN THIS SYSTEM IS FOR YOU!

Remember, it doesn't matter how many times you have tried to lose weight, your time has finally come, with the Amazing Fat Burning System!

A healthy slim, trim and energetic figure is our goal--make it yours!

SEE DRAMATIC RESULTS IN JUST DAYS...OR RETURN EVERYTHING FOR A FULL REFUND!

You have nothing to loose except fat. Try the Amazing Fat Burning System for a couple of weeks--if you don't feel that the results are fantastic in every way, you can return the system to us, and you'll get a full refund. Just like that! No questions asked.

Give it a try today.

Brad Mitchell
27313 Plymouth Rd., Dept SC-1
Detroit, Michigan 48239

Okay, Brad, I accept your offer! But I've got to feel that the Amazing Fat Burning System is the greatest and that the results will be nothing short of miraculous. Otherwise I'll send everything back for a full refund! I enclose $9.95. (cash, check or money order)

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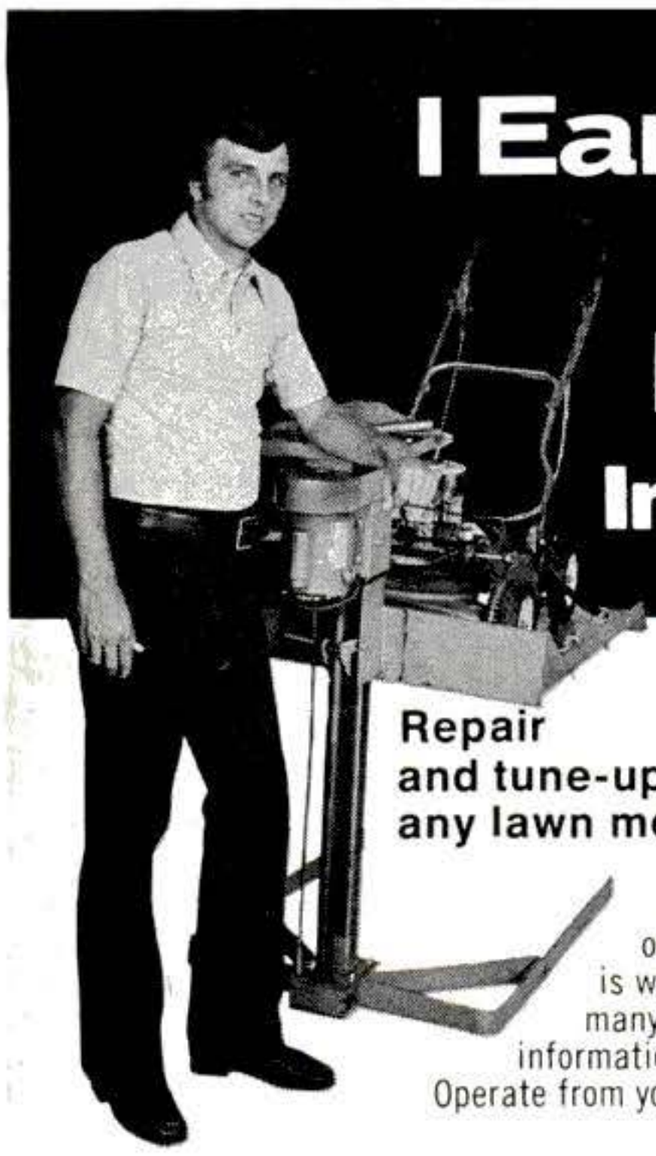

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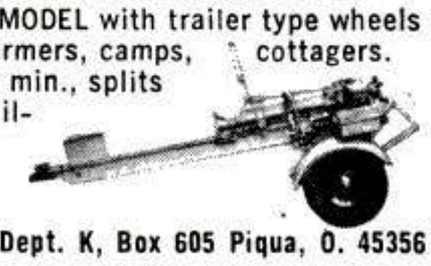

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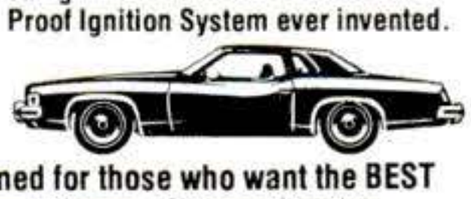

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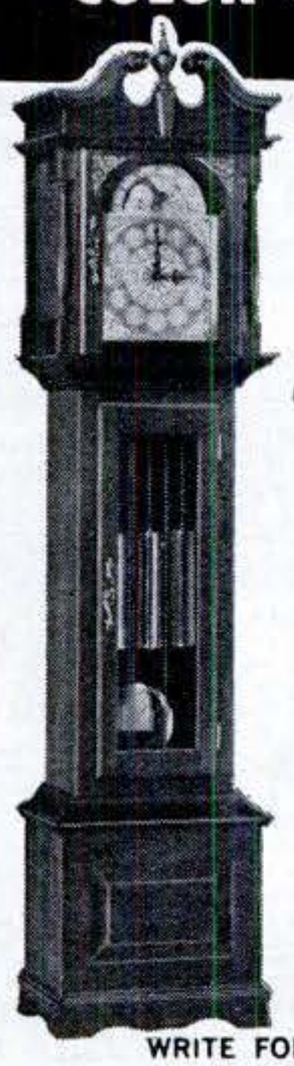

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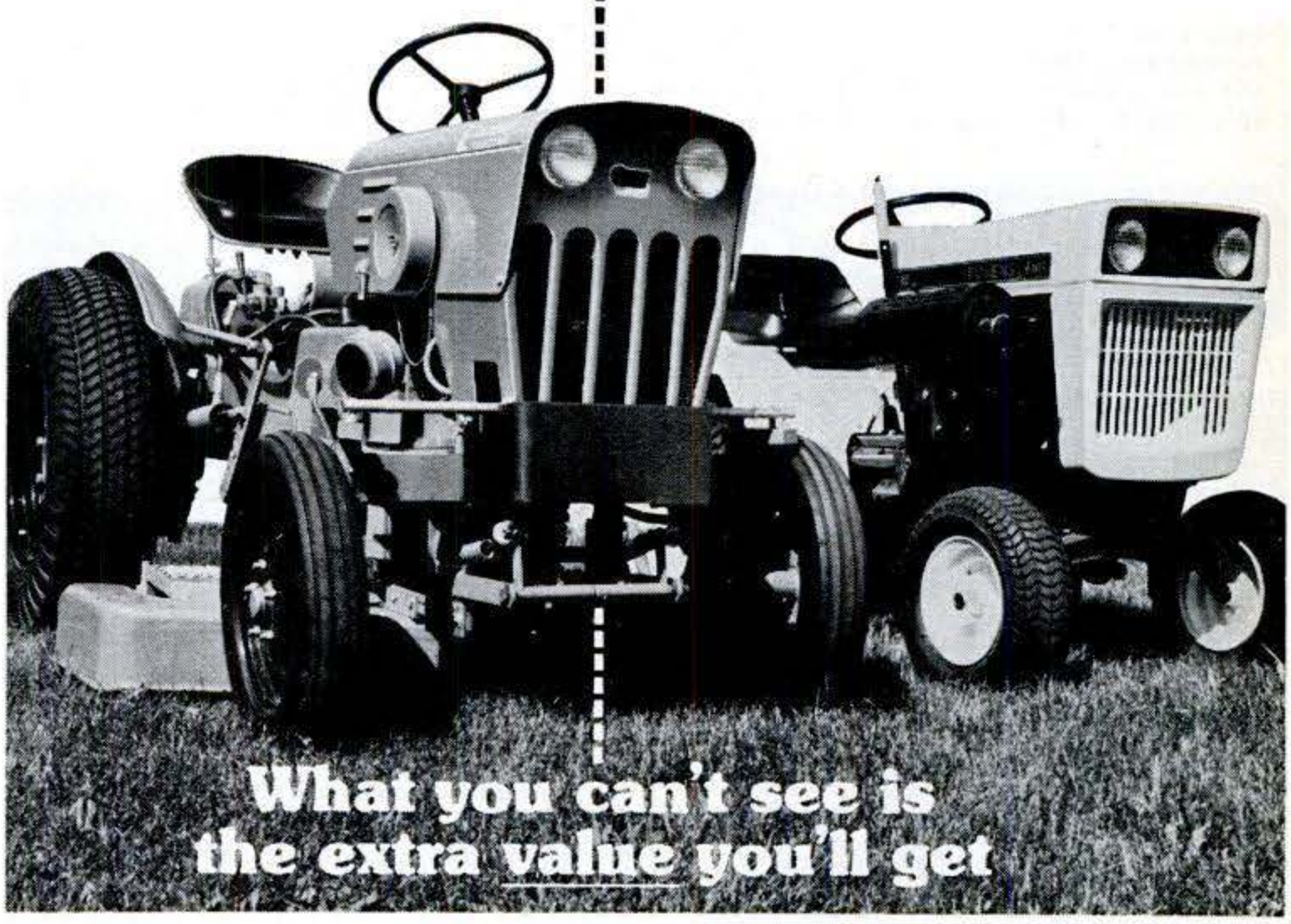

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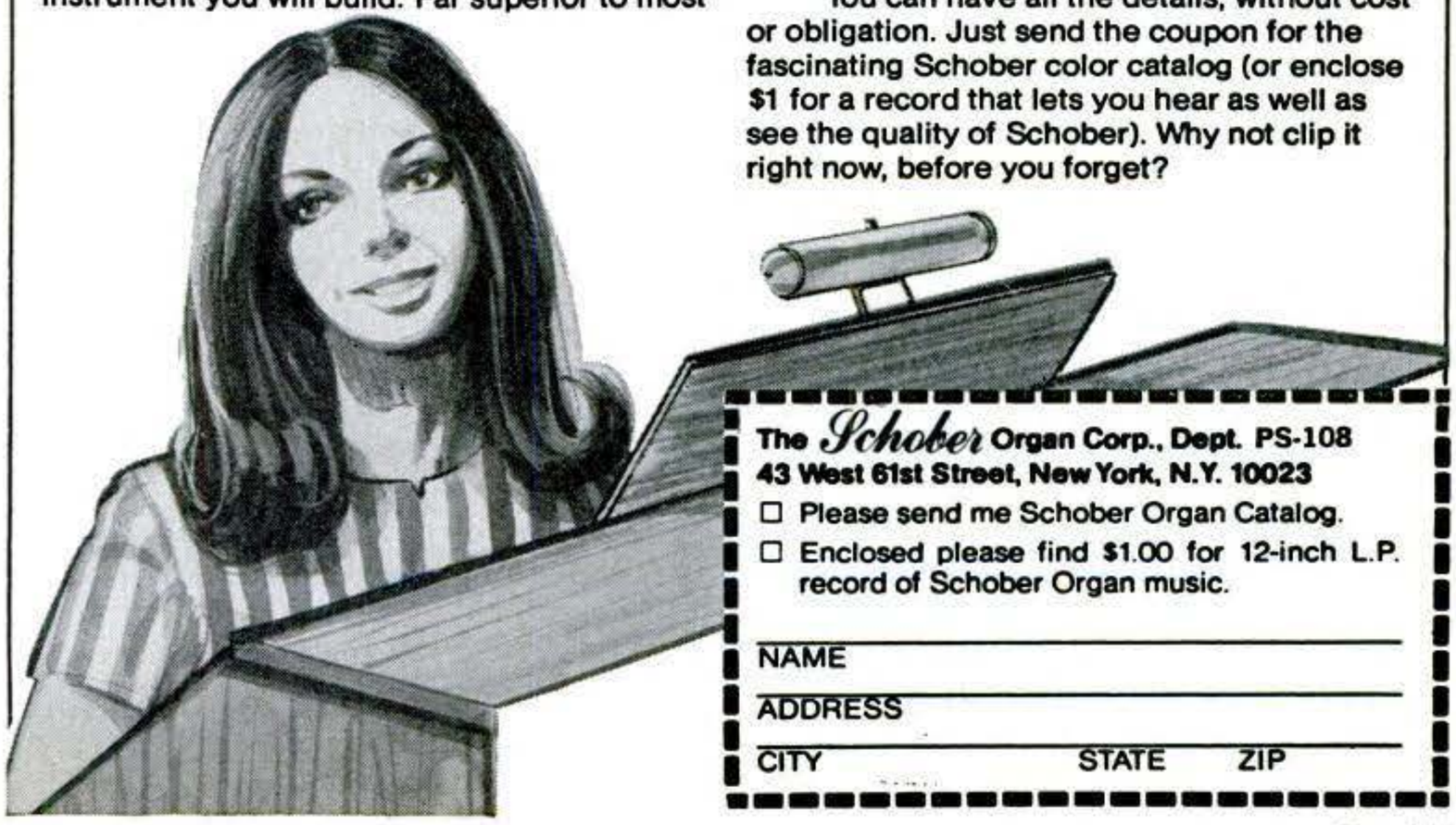

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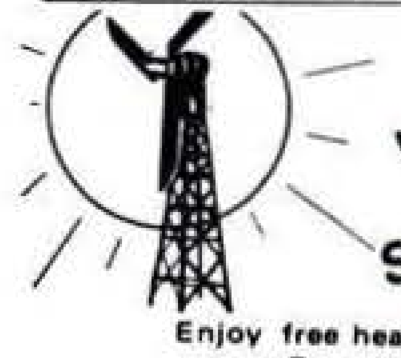

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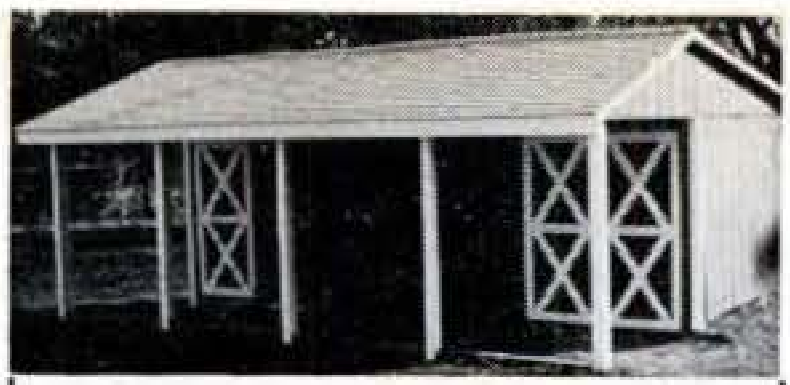

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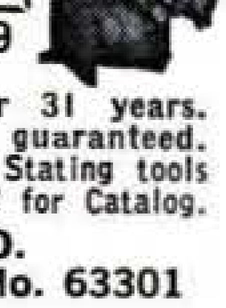

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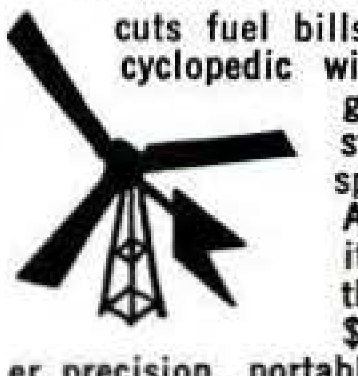

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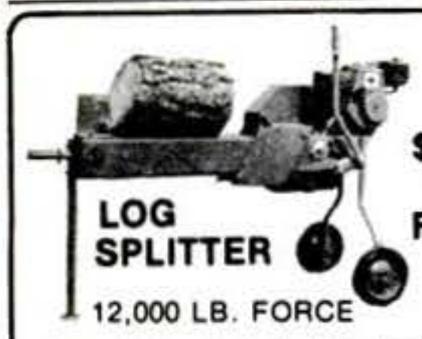

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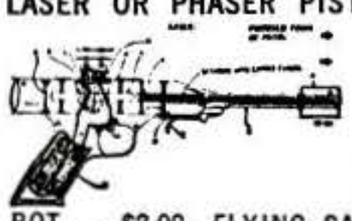

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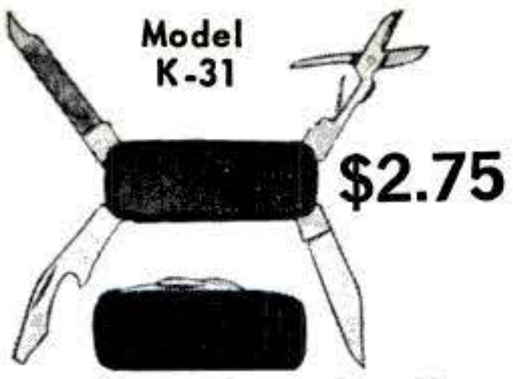

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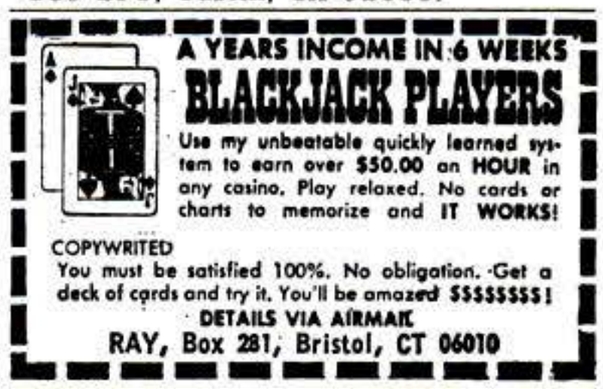

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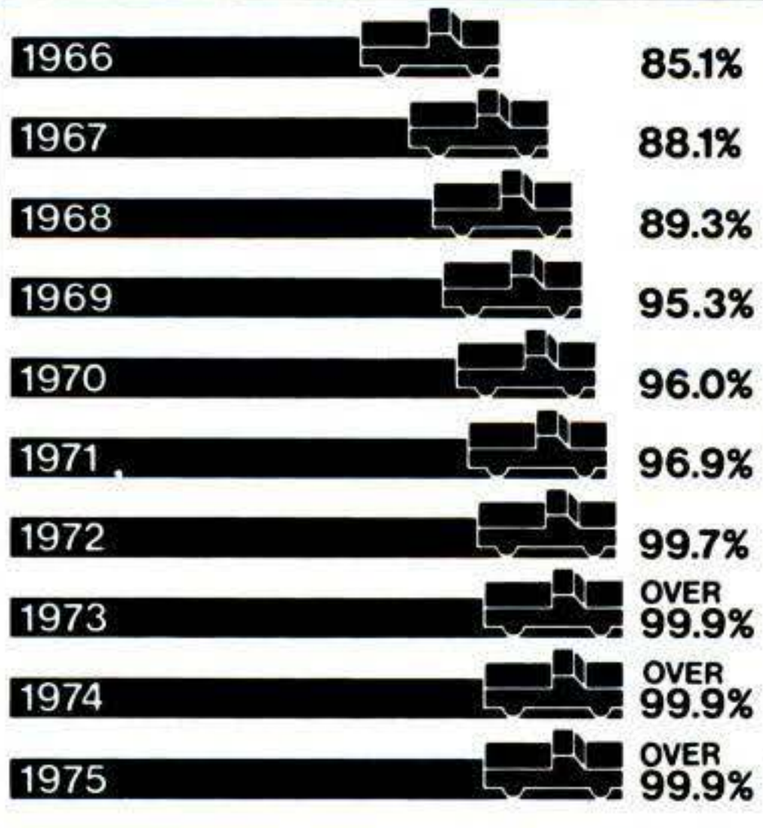

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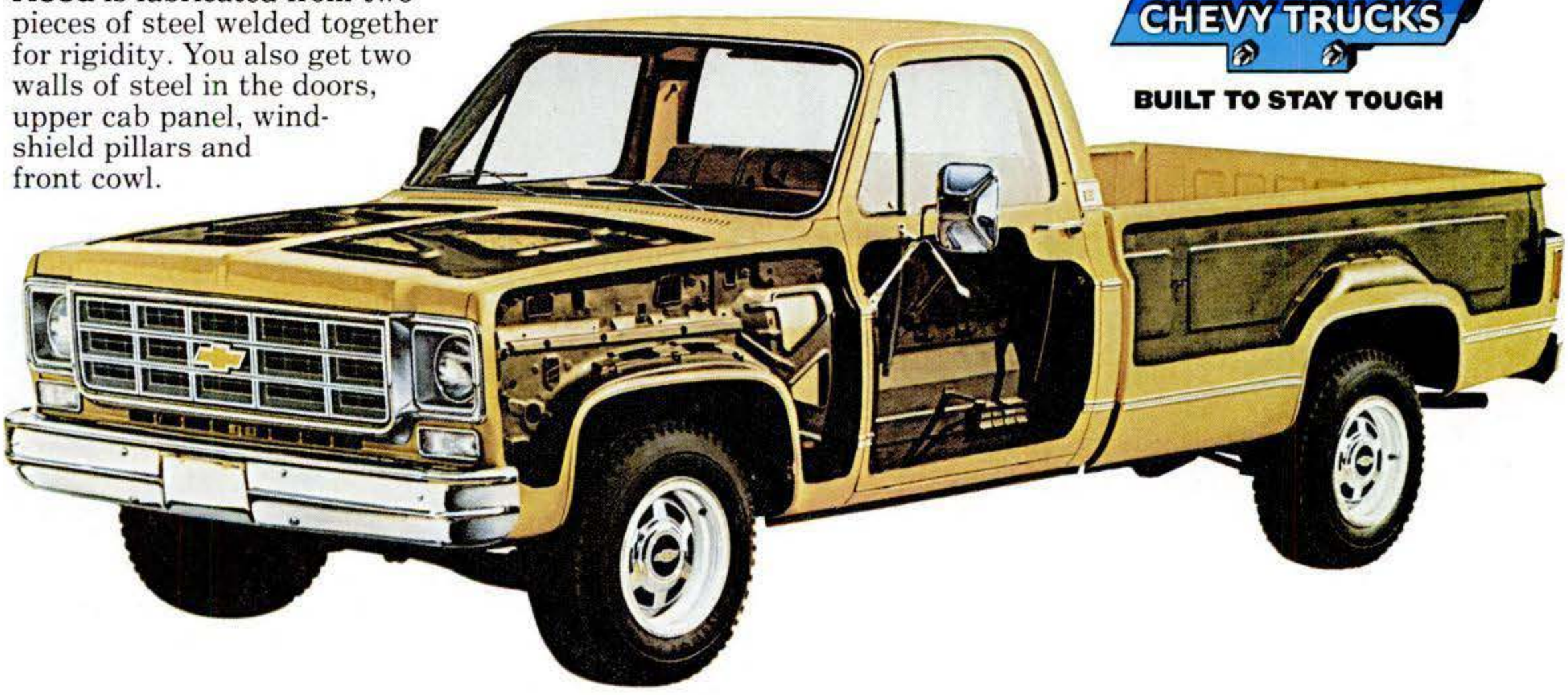

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